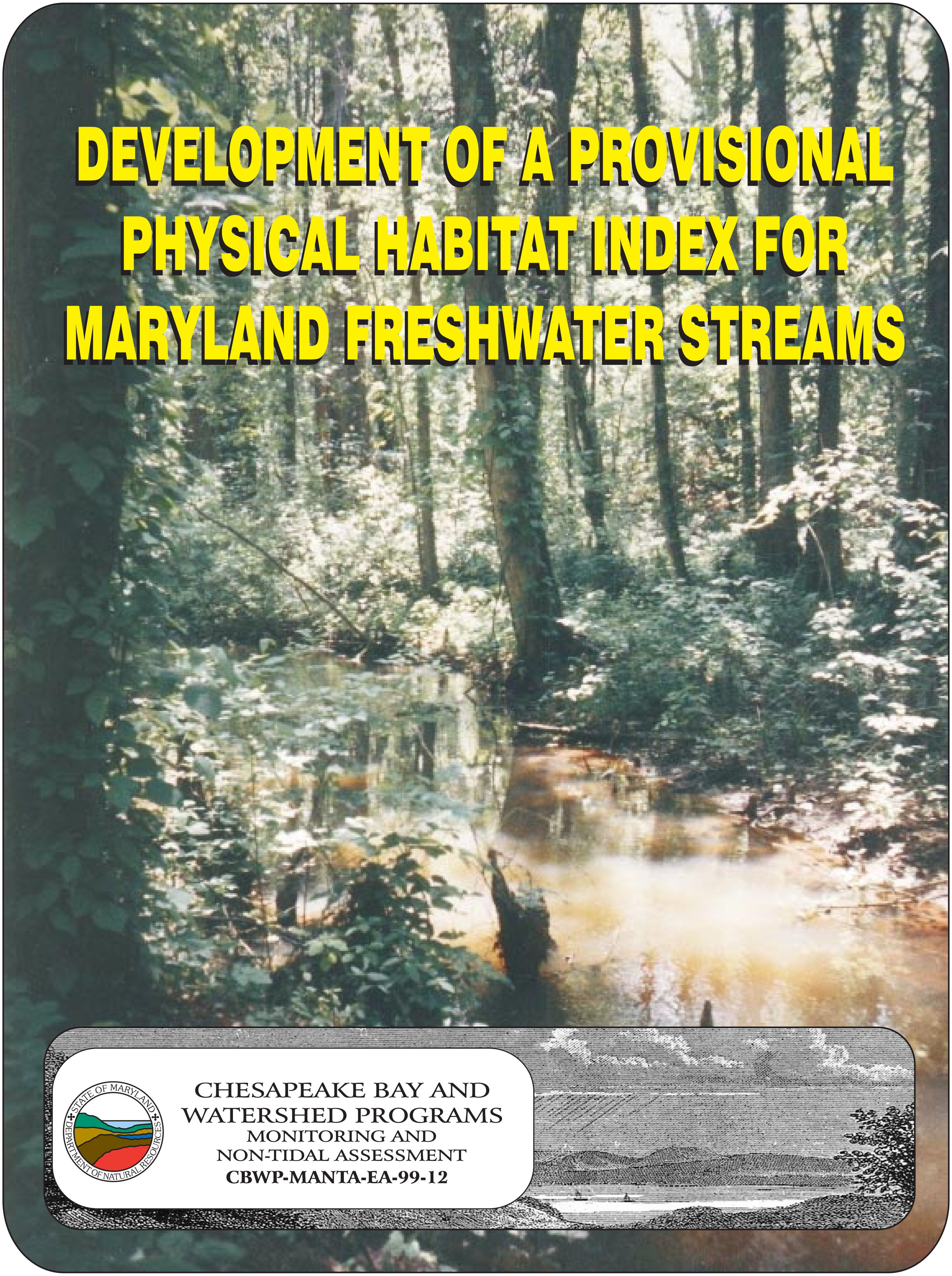
DEVELOPMENT OF A PROVISIONAL PHYSICAL HABITAT INDEX FOR MARYLAND FRESHWATER STREAMS



CHESAPEAKE BAY AND
WATERSHED PROGRAMS
MONITORING AND
NON-TIDAL ASSESSMENT

CBWP-MANTA-EA-99-12

Parris N. Glendening
Governor

Kathleen K. Townsend
Lieutenant Governor

A message to Maryland's citizens

The Maryland Department of Natural Resources (DNR) seeks to preserve, protect and enhance the living resources of the state. Working in partnership with the citizens of Maryland, this worthwhile goal will become a reality. This publication provides information that will increase your understanding of how DNR strives to reach that goal through its many diverse programs.

Sarah Taylor-Rogers
Secretary

Stanley K. Arthur
Deputy Secretary

Maryland Department of Natural Resources
Tawes State Office Building
580 Taylor Avenue
Annapolis, Maryland 21401

Toll free number: 1-(877) 620 8DNR x8611
www.dnr.state.md.us

FOR FURTHER INFORMATION REGARDING THIS REPORT, PLEASE CALL 410-260-8611.
OR TOLL FREE : 1 (877) 620-8DNR x 8611

PRINTED ON RECYCLED PAPER

October 1999
Final Report

Development of a Provisional Physical Habitat Index for Maryland Freshwater Streams

Lenwood W. Hall, Jr.
University of Maryland
Agricultural Experiment Station
Wye Research and Education Center
Queenstown, Maryland 21658

Raymond P. Morgan II
University of Maryland
Center for Environmental Science
Appalachian Laboratory
Frostburg, Maryland 21532-2307

Elgin S. Perry
2000 Kings Landing Road
Huntingtown, Maryland 20639

and

Anita Waltz
University of Maryland
Center for Environmental Science
Appalachian Laboratory
Frostburg, Maryland 21532-2307

FOREWORD

This report entitled "Development of a Provisional Physical Habitat Index for Maryland Freshwater Streams" supports the Maryland Department of Natural Resources' Maryland Biological Stream Survey (MBSS) under the direction of Dr. Ronald Klauda and Mr. Paul Kazyak of the Monitoring and Non-Tidal Assessment Division (MANTA). This was a cooperative effort between Lenwood Hall of the University of Maryland's Wye Research and Education Center (Contract Number MA98-003-031) and Raymond Morgan of the University of Maryland's Center for Environmental Science Appalachian Laboratory **(**Contract Number MA98-001-031**).** The primary goals of this study were to: (1) use existing biological, chemical, land use and physical habitat data from the 1994-97 Maryland Biological Stream Survey (MBSS) to determine the discriminatory power of physical habitat metrics in assessing the quality of non-tidal streams in Maryland and (2) select the metrics with the best discriminatory power to develop a provisional physical habitat index for non-tidal streams in both Coastal and Non-Coastal Plain strata in Maryland. Additional analysis was also conducted to determine the relationship of various physical habitat metrics with biological indices, land use and stream characteristics.

EXECUTIVE SUMMARY

Physical habitat is the living space for instream aquatic organisms. It is a spatially and temporally dynamic entity determined by the interaction of structural features of a stream channel and hydrological regime. Physical habitat is particularly critical for healthy fish communities and it was evaluated using a wide range of standard metrics during the first round of the state-wide Maryland Biological Stream Survey (MBSS) in the mid 1990s. A research need identified from these data was a specific physical habitat index for Maryland freshwater streams. The major objectives of this study were to: (1) use existing biological, chemical and physical habitat data from the 1994-97 Maryland Biological Stream Survey (MBSS) to determine the discriminatory power of physical habitat metrics for assessing the quality of non-tidal streams in Maryland and (2) develop a provisional multimetric Maryland Physical Habitat Index (MPHI) for both Coastal and Non-Coastal Plain stream strata using metrics that showed the best discriminatory power in reference and degraded conditions. Biological, chemical and land-use data were used to determine reference and impacted sites. In addition to the major objective described above, additional analyses were also conducted with the 1994-97 MBSS data to address the following: (1) compare MPHI, Fish Index of Biotic Integrity (IBI), Benthic IBI and stream characteristics; (2) determine the relationship of the herpetofauna presence data with physical habitat metrics; (3) compare the variability of the subjective physical habitat assessments by metrics among field crews (Appalachian Laboratory - AL; Wye Research and Education Center - WREC; and Department of Natural Resources - DNR) with the DNR Quality Control officer scores; (4) evaluate the relationship between land/use habitat metrics and instream continuous habitat metrics and (5) test the concept of habitat quantity (stream volume) and habitat quality (MPHI) to characterize expectations for fish abundance, richness and IBI (quantity as well as quality of habitat will influence the number of fish).

The two geographical strata used to develop and validate a provisional physical habitat index in Maryland non-tidal streams were the Coastal Plain (386 sites) and Non-Coastal Plain (674 sites in the Appalachian Plateau, Valley and Ridge, Blue Ridge and Piedmont physiographic regions). For both strata, there was a lower frequency of small reference streams (1st order) and larger degraded (3rd order) streams. Results from our analysis also demonstrated that many of the physical habitat metrics such as instream habitat, velocity/depth diversity, pool/glide/eddy quality, embeddedness and maximum depth correlated with watershed size.

Provisional habitat indices were developed using Principal Components Analysis (PCA) and stepwise discriminate analysis. The index that assumed redundancy of metrics was efficient (e.g. include two metrics even if they give similar information) performed best with the Non-Coastal Plain data. In contrast, the index that assumed redundancy was inefficient and selected only the best discriminatory metrics preformed best with the Coastal Plain data. Due to the inconsistent influence of redundancy for the provisional indices for each strata, the final core metrics were selected based on their ability to consistently discriminate between reference and degraded sites across stream orders and years.

Physical habitat metrics with the best discriminatory power for Coastal Plain streams were: instream habitat, velocity/depth diversity, pool/glide/eddy quality, embeddedness, maximum depth and aesthetic rating. The final index calculations for the Coastal Plain weighted all metrics equally except embeddedness, maximum depth and aesthetics which were weighted ½. The final equation used for the Coastal Plain Physical Habitat Index (CPPHI) was: CPPHI = (instream habitat + velocity/ depth diversity + pool quality - embeddedness/10 + maximum depth/10 + aesthetics/2)/6. Physical habitat metrics with the best discriminatory power for Non-Coastal Plain sites were: instream habitat, velocity/depth diversity, riffle/run quality, embeddedness, number of rootwads and aesthetic rating. All of these metrics were weighted equally except embeddedness (weighted ½ and aesthetics (weighted $^1/_3$). The final equation used for the Non-Coastal Plain Physical Habitat Index (NCPPHI) was: NCPPHI = (instream habitat + velocity/depth diversity + riffle/run quality - embeddedness/10 + 3 x number of rootwads + aesthetics/3)/6. Instream habitat, velocity/depth diversity, embeddedness and aesthetics were four metrics that performed well in both strata.

The overall classification efficiency (correct designation of degraded and reference sites) for index validation was 76% for both indices pooled over both strata. Scaled MPHI values (0-100) for both strata showed that there were nearly twice as many good sites (31%) as very poor sites (16%). More than half the sites were in the poor to fair range **(**53**%).**

A comparison of MPHI, Fish IBI scores, Benthic IBI scores and stream size characteristics (order and volume) showed that the MPHI and Fish IBI were significantly correlated with stream size characteristics. The Benthic IBI had a low correlation with the MPHI and stream size characteristics and is therefore useful as an independent measure of stream quality, particularly in small streams. MPHI, Benthic IBI and stream size characteristics all significantly influenced Fish IBI scores. Larger streams had higher MPHI and Fish IBI scores.

Shading, riparian width and remoteness had the largest number of positive relationships with the presence of 53 different herpetofaunal species of salamanders, toads, lizards, turtles, frogs and toads. There were strong interrelationships among these three metrics. Shading present at a stream site is a function of riparian width and plant species composition; remote areas also tend to have better riparian habitat. Conversely, those metrics more related to channel characteristics (velocity/depth) and flow (channel flow) generally do not strongly affect the presence or absence of herpetofauna. The exception was channel alteration which positively influenced herpetofauna. This metric likely serves as a surrogate for bank stability and may reflect the presence of suitable bank habitat. The highest number of negative relationships occurred with embeddedness, volume, bank stability and maximum depth. Since embeddedness is a measure of stream sediment, outside sediment sources from the same habitat used by herpetofauna may indicate significant streamside alteration resulting in poor habitat for this assemblage of species. Stream volume likely relates to the observation that herpetofauna (especially salamanders and newts) are not common along the larger streams and prefer smaller first order streams.

To provide a quality assurance measure for physical habitat assessments performed during MBSS sampling, a comparison was made of habitat metric scoring between the Quality Control Officer and three different field crews (AL, WREC and DNR). A metric-by-metric comparison between the Quality Control Officer and the various field crews generally showed that scoring of metrics was similar.

The relationship between the core habitat metrics and various land use characteristics generally confirmed logical relationships that would be expected. For example, the aesthetics metric was positively correlated with both deciduous forest and coniferous forest land uses and negatively correlated with residential areas. Embeddedness was positively correlated with wetlands (areas with sediment accumulation). Instream habitat was positively correlated with deciduous forest and coniferous forest (land use with minimal human impact) and negatively correlated with commercial/ industrial development, cropland and pasture. For the habitat metrics with less discriminatory power, it was noteworthy that deciduous/coniferous forests positively correlated with bank stability, epifaunal substrate, remoteness, riparian width and shading. Residential and commercial/industrial areas were negatively correlated with remoteness and riparian width.

MPHI (habitat quality) and stream volume (habitat quantity) influenced various characteristics of the fish community such as abundance per square meter, species richness and Fish

IBI scores. The MPHI had the highest correlation with number of species, a lower correlation with Fish IBI scores and the lowest correlation with abundance per square meter. Stream volume was also highly correlated with the number of species and less correlated with the Fish IBI. Stream volume and fish abundance per square meter were negatively correlated. Various physical habitat metrics were important in predicting the three measures of the fish community but stream volume was the single most consistent and influential variable for all three measures.

ACKNOWLEDGMENTS

Maryland Department of Natural Resources Monitoring and Non-tidal Assessment Division (MANTA) is acknowledged for supporting this study (DNR Contract # MA98-003-031 for the Wye Research and Education Center and Contract # MA98-001-031 for Appalachian Laboratory). Versar Inc. and Tetra Tech Inc. are acknowledged for providing data files for the analysis.

TABLE OF CONTENTS

Foreword i

Executive Summary ii

Acknowledgments vii

Table of Contents. viii

List of Tables x

List of Figures xi

1. Introduction 1

2. Methods 4
    2.1 Data Base Development 4
    2.2 Identify Reference and Degraded Streams 4
    2.3 Determine Strata 6
    2.4 Assess Discriminatory Power of Metrics 6
    2.5 Select Core Metric and Combine into an Index 7
    2.6 Validate the Index 9
    2.7 Assess Categories for Final MPHI Scores 10
    2.8 Additional Tasks 11
        2.8.1 Comparison of MPHI, Fish IBI, Benthic IBI and Stream Characteristics 11
        2.8.2 Relationship of Herpetofauna Presence/Absence with Habitat Metrics . . . 11
        2.8.3 Compare Quality Control Scores with the Three Field Crews 12
        2.8.4 Relationship Between Landuse Characteristics and Instream Continuous Habitat Metrics 12
        2.8.5 Influence of Habitat Quantity versus Quality on Fish Communities 12

3. Results 14
    3.1 Determine Strata 14
    3.2 Identify Reference and Degradded 14
    3.3 Assess Discriminatory Power of Metrics 15
    3.4 Select Core Metrics and Combine into an Index 17
    3.5 Validate the Index 22
    3.6 Assess Categories for Final MPHI Scores 24
    3.7 Additional Tasks 25
        3.7.1 Comparison of MPHI, Fish IBI, Benthic IBI and Stream Characteristics . 25
        3.7.2 Relationship of Herpetofauna Presence/Absence with Habitat Metrics . . . 27
        3.7.3 Compare Quality Control Scores with the Three Field Crews 28

TABLE OF CONTENTS - CONTINUED

3.7.4 Relationship between Landuse Characteristics and Instream Continuous Habitat Metrics 29
3.7.5 Influence of Habitat Quantity versus Quality on Fish Communities 30

4. Summary 33

5. References 36

Appendices

Appendix A - Classification of Coastal and Non-Coastal Streams as degraded (D), reference (R) and unclassified (U) for 1994-96.

Appendix B - Summary of Principal Components Analysis (PCA), stepwise discriminate analysis and stepwise logistic regression for MPHI development in both Coastal and Non-Coastal Plain strata.

Appendix C - A cross tabulation between each field crew and the Quality Control officer for each categorical metric.

LIST OF TABLES

Table 2.1 Physical habitat assessment data sheet 39
Table 3.1 Frequency of coastal plain stream sites (1994-97) by stream order 40
Table 3.2 Frequency of non-coastal plain stream sites (1994-97) by stream order 41
Table 3.3 Pooled t-test results for each continuous metric by strata 42
Table 3.4 The results of Chi-square analysis of categorical metrics for each strata 43
Table 3.5 Summary of results from consistency over stream order analysis 46
Table 3.6 Summary of results from consistency over years analysis 47
Table 3.7 Cutpoints computed for using the MPHI formula for the habitat index 48
Table 3.8 Frequency of MPHI categories for Coastal Plain, Non-Coastal Plain and all sites 49
Table 3.9 Pearson Correlation Coefficients for fish IBI scores, 98 fish IBI scores benthic IBI scores, stream order and stream volume 50
Table 3.10 Multiple Linear Regression analysis for determining how well the fish IBI can be predicted by the combination of stream size, MPHI and the benthic IBI51 51
Table 3.11 Herpetofauna presence by site in descending order 52
Table 3.12 Correlation analysis used to determine the relationship of herpetofauna data with habitat metrics and volume. Relationships are positive (+), negative (-) and not significant (.) ($p>0.05$) 53
Table 3.13 Summary of comparisons between crew scores and the QC officer scores for the continuous habitate metrics 54
Table 3.14 Frequency of occurrence of land use characteristics 56
Table 3.15 Logistic regression results for each landuse-instream pair are summarized as positive (+), negative (-) or not significant (.) ($p>0.05$) 57
Table 3.16 Order dependent regressions of quantity (volume) and quality (SMPHI) against three measures of fish community richness 58
Table 3.17 Pearson Correlation Coefficients for paired sets of the following: ABUNDSQM (total abundance of fish/m^2); NSPEC (Number of fish species); FISHIBI (Fish Index of Biotic Integrity); Volume (volume of area sampled); SMPHI (Scaled Maryland Physical Habitat Index) 59
Table 3.18 Summary of stepwise regression procedure for the dependent variable ABUNSQM (abundance per square meter) 60
Table 3.19 Summary of stepwise regression procedure for the dependent variable NSPEC (number of fish species) 61
Table 3.20 Summary of stepwise regression procedure for the dependent variable FISHIBI (fish index of biotic integrity) 62

LIST OF FIGURES

Figure 3.1 Box and Whisker plots of NSPEC (number of fish species) for Coastal Plain streams in < 300 acre watersheds 63
Figure 3.2 Box and Whisker plots of NSPEC (number of fish species) for Non-Coastal Plain streams in < 300 acre watersheds 64
Figure 3.3 Box and Whisker plots for degraded and reference Coastal and Non-Coastal Plain streams sites by continuous metric 65
Figure 3.4 Parallel axis plots for sites with good fish IBI scores (Fish IBI > 4.0) and MPHI scores separated by category 73
Figure 3.5 Parallel axis plots for sites with very poor Fish IBI scores (Fish IBI < 2.0) and MPHI scores separated by category 74
Figure 3.6 Percent of occupied stream miles by physiographic province: A= Allegheny Plateau; V=Great Valley; B=Blue Ridge; P=Piedmont; N=Northern Coastal Plain and S=Southern Coastal Plain 75

SECTION 1
INTRODUCTION

The importance of physical habitat in determining the condition of a stream or river is implicit in its definition because without a suitable “living space” a given species is unlikely to exist at that particular location (Maddock, 1999). The presence of physical habitat in freshwater streams is particularly important for stream fish communities because it influences the composition and status of this biological assemblage (Gorman and Karr, 1978). Because physical habitat is such an important factor influencing biological communities in streams, it was assessed concurrently with fish sampling during the first round of the statewide Maryland Biological Stream Survey (MBSS) from 1994 to 1997.

Over the last quarter century, fish communities have been extensively used to assess freshwater ecosystem health (Simon, 1999). Significant advances in this research area led to the development of integrative multimetric ecological indices, such as Indices of Biotic Integrity (IBI), that relate fish communities to both biotic and abiotic ecosystem components (Karr, 1981; Karr et al., 1986). Coupled with chemical-physical water quality, habitat quality is important to consider when examining the status of fish communities, especially those characterized by IBIs (Yoder and Smith, 1999).

Unfortunately, indices of habitat quality have lagged behind fish IBI development. One reason is the difficulty in developing accurate, precise and complete measurements to quantitatively and qualitatively assess habitat conditions (Platts, 1976; Platts et al., 1983). Impetus for including habitat as an important measure came initially from studies conducted in western areas of the United States (reviewed in Platts et al., 1983). For example, Binns (1979) developed a Habitat Quality Index for trout streams, soon followed by an Aquatic Habitat Evaluation Procedures Model (HEP) and Habitat Suitability Index (HSI) for use with the in-stream flow models of the Fish and Wildlife Service. Improvements in more generalized habitat models came with the development of EPA's Rapid Bioassessment Protocols (Plafkin et al., 1989) and the Ohio EPA's Qualitative Habitat Evaluation Index (Rankin, 1989). It should also be noted that Van Deusen (1954) developed a watershed classification system for Maryland which was perhaps one of the first attempts at using habitat indicators in the United States.

Platts et al. (1983) reported that techniques designed to evaluate stream habitat conditions are often untested. These investigators pointed out that many habitat assessments have been designed to optimize time, rather than precisely measure habitat conditions. Consequently, it is critical to have a physical habitat index that has been rigorously tested to minimize errors in data interpretation and reduce uncertainty in resource management decisions. Physical habitat indices developed using quantitative statistical procedures are rare (Wang et al., in press).

Procedures for physical habitat assessment used during the MBSS were derived from two currently used methodologies: EPA's Rapid Bioassessment Protocol (RBPs) (Plafkin et al., 1989) as modified by Barbour and Stribling (1991) and the Ohio EPA's Qualitative Habitat Evaluation Index (Rankin , 1989). A total of 13 continuous physical habitat metrics were measured at stream sites along with additional qualitative stream characteristics (meandering, presence of emergent and submergent vegetation etc.) and quantitative variables (e. g. flow).

Although the stream habitat metrics and stream characteristics provide useful information about a stream's biological capacity and function, a quantitative assessment of the importance of the various metrics in influencing biotic communities has not been conducted in Maryland non-tidal streams. The goal of this study was to use existing MBSS data from 1994-97 to evaluate the importance (discriminatory power) of various metrics in determining biological integrity and/or fishability. From a core group of metrics demonstrating good discriminatory power, a provisional multimetric Maryland Physical Habitat Index (MPHI) was developed for both Coastal Plain and Non-Coastal Plain freshwater streams in the state. Based on analyses conducted for both fish and benthic IBI development in Maryland, it was anticipated that a separate physical index may be needed for the Coastal Plain and Non-Coastal Plain strata (Roth et al., 1998; Stribling et al., 1998). It was also suspected that a certain group of core metrics would be useful for each strata.

The approach used to develop the MPHI consisted of the following phases:

- Organize the MBSS data base (1994-1997) for analysis and conduct quality control assessments
- Identify reference and degraded streams based on biological, chemical, and land-use data
- Determine strata (Coastal and Non-Coastal Plain stream sites)
- Assess discriminatory power of metrics
- Select core metrics and combine into an index
- Validate index
- Assess habitat condition categories for final habitat scores (good, fair, poor and very poor)

In addition to the various tasks described above, additional analyses were also conducted with the 1994-97 MBSS data to address the following objectives: (1) compare MPHI, Fish IBI, Benthic IBI and stream characteristics; (2) determine relationships between the herpetofauna presence data and physical habitat metrics; (3) compare the variability of the subjective physical habitat assessments by metric among field crews with the DNR Quality Control officer scores; (4) evaluate the relationship between land/use habitat metrics and instream continuous habitat metrics and (5) test the concept of habitat quantity (volume) and habitat quality (MPHI) to characterize expectations for fish abundance, richness and IBI.

SECTION 2
METHODS

A description of the methods used for each phase of the study is presented below.

2.1 Data Base Development

The 1994-1997 MBSS quantitative and qualitative physical habitat data, fish IBI scores (including individual metrics) and water quality data that currently exist on data files (Lotus and SAS format) for approximately 1100 sites in the Coastal and Non-Coastal Plain of Maryland were used for the analysis. A description of the probability based sampling design that was used to select these first through third order non-tidal streams used for this analysis is found in Roth et al. (1999).

Physical habitat assessments were conducted at all stream sites using procedures detailed in Kazyak (1997). These procedures were similar to assessment techniques used by other investigators (Plafkin et al., 1989; Barbour and Stribling, 1991; Rankin, 1989). Physical habitat data were used to scale to determine the distribution of the various habitat metrics measured in the MBSS (Table 2.1). There are two types of physical habitat metrics: continuous metrics (1-13) and categorical metrics (presence/absence). For the continuous metrics, the scoring of metrics 1 through 7 , 12 and 13 uses a scale of 0 to 20 while some of the other metrics use a percentage(#8, 9, and 10). All metrics were converted on the same scale for analysis (percentages were converted to a 0 to 20 scale). Bill Killen of the Wye Research and Education Center (WREC) and Matt Kline of Appalachian Laboratory (AL) completed a number of quality control checks on the data files to insure accuracy before analysis was initiated.

2.2 Identify Reference and Degraded Sites

It is necessary to establish expectations for minimally degraded or "reference" sites in order to develop a MPHI that can be used across a range of degradation. Biological, chemical and land-use characteristics were used to determine reference and impacted sites. Fish IBI scores from the 1994-1997 data base were used to assess the quality of the various sites. Criteria used by Roth et al. (1998) for the Maryland fish IBI, excluding the physical habitat criteria, were used in this analysis. The criteria for reference and degraded sites were defined as follows:

Reference Sites (sites meet all seven criteria)

- Fish IBI scores ≥ 4 (5 is maximum)
- pH ≥ 6 or blackwater streams (pH < 6 and DOC ≥ 8 mg/L)
- ANC ≥ 50 ueq/L
- Dissolved oxygen ≥ 4 mg/L
- Nitrate ≤ 4.2 mg/L
- Urban land use $\leq 20\%$ of catchment area
- Forest land use $\geq 25\%$ of catchment area

Degraded Sites (only sites with Fish IBI scores <2.5 were considered degraded in the analysis)

- Fish IBI ≤ 2.5
- pH ≤ 5 and ANC ≤ 0 ueq/L (except for blackwater streams DOC ≥ 8 mg/L)
- Dissolved oxygen ≤ 2 mg/L
- Nitrate > 7 mg/L and dissolved oxygen < 3 mg/L

To enhance the identification of metrics that discriminate between the extremes of reference and degraded sites, sites were classified as reference, clearly degraded, and unclassified. Sites that were classified as clearly degraded were scrutinized and those that were degraded as a result of non-habitat related factors, such as low pH , were moved to the unclassified set. To be considered a degraded site, the first criteria (Fish IBI ≤ 2.5) must have been met. Field data sheets and notes from the data notebooks were reviewed by the field crew leaders to identify sites that had low fish IBI scores related to non-habitat related factors (< 5% of the sites). For small streams with catchment areas less than 300 acres (called 0 order in our analysis), fish IBI scores were not calculated. Therefore, we used species richness as a replacement for IBI scores for these cases. Richness criteria for these small streams were $\geq$ 5 species for reference sites and $\leq$ 1 species for degraded sites (see Section 3.2).

2.3 Determine Strata

The sponsors and the Principal Investigators agreed that the logical partitioning of sites for developing the MPHI should coincide with the strata used for the previously developed Maryland non-tidal stream fish IBI. Cluster analysis and MANOVA used by Roth et al. (1998) for developing the fish IBI identified two strata: Coastal Plain and Non-Coastal Plain (Appalachian Plateau, Valley and Ridge, Blue Ridge, and Piedmont regions). These two geographic strata selected for MPHI development are consistent with aggregations of ecoregions (Omernik, 1987) and physiographic provinces developed for Maryland (Reger, 1995).

2.4 Assess Discriminatory Power of Metrics

A total of 13 continuous physical habitat metrics along with various stream characteristics (presence of meandering, channelization, rootwads etc) and land use characteristics are used in the current MBSS evaluation of physical habitat in streams (Table 2.1). These continuous metrics are grouped into the following categories: structural (1-5), hydrological (6-9), vegetative (10 and 11) and visual appeal (12 and 13). The relationship of the various continuous metrics, appropriate stream characteristics and quantitative variables (categorical metrics) to fish IBI scores and individual fish IBI metrics (e. g. species richness, abundance) was determined .

The following analysis was conducted for the continuous metrics: (1) side -by-side Box and Whisker plots were used to visually assess the displacement and overlap of each metric between reference and degraded sites and (2) Pooled T-tests were used to test for differences in means between reference and degraded sites for continuous metrics.

The discriminatory power of categorical metrics was measured by using a Chi-square analysis of a 2x2 table formed by cross classifying site status (reference/degraded) with each stream characteristic (e.g. meandering/not meandering). Metrics that were found to differ significantly ($p<0.05$) were considered to have discriminatory power and were considered later in the final index development.

The discriminatory power of both continuous and categorical metrics was evaluated separately for both strata (Coastal and Non-Coastal Plain sites). Metrics showing significant discriminatory power were then used in the analysis described below.

2.5 Select Core Metrics and Combine into an Index

Initially, two philosophies for selecting core metrics were applied. One philosophy prescribed that redundancy among metrics should be eliminated when constructing the index and thus sought to identify the smallest set of metrics that yields efficient discrimination between reference and degraded sites. A second philosophy prescribed that retaining some redundancy among the core metrics is constructive and the index was developed to retain redundancy. As the study progressed, it became clear that it was necessary to assess the consistency of discriminatory power over years and across stream order to develop a successful habitat index.

The first step of the metric selection process was to assess the redundancy among the continuous metrics using Principal Component Analysis (PCA). The PCA analysis was also conducted for the categorical metrics. Following the PCA, two habitat indices were developed. One based on using redundancy as identified by the PCA (assuming redundancy is constructive) and one based on selecting the most efficient set of individual metrics (assumes that redundancy is not constructive). The index based on redundancy was developed using stepwise logistic regression on PCA scores computed from the individual metrics and the index based on the minimal set for efficiency was developed using stepwise logistic regression on individual metrics. The two indices were validated and compared using 1997 data and the results were inconclusive. The index that employed redundancy performed best in the Non-Coastal strata and the index based on efficiency (assuming that redundancy is not constructive) performed best for Coastal Plain streams in spite of indications to the contrary when evaluated on the training data. These results prompted additional analysis (Two -Way Analysis of Variance (ANOVA)) to assess the consistency of discriminatory power of metrics over stream order and year as additional criteria for selecting metrics to use in the index. This ANOVA contrasted reference and degraded streams with both stream order and year to demonstrate the discriminatory power of metrics. **Metrics had to show consistent discriminatory power across stream orders and years to be selected as core metrics.**

A boot strap resampling analysis was conducted to address two questions. Are there metrics other than those that met the discrimination and consistency criteria that might still be useful in the habitat index? What is the discrimination efficiency of the index when employed on independent data? Eighty percent of the 1994-97 MBSS data set was randomly subsampled for 100 trials. These data were used in a stepwise regression to identify metrics (4 to 6) in addition to those meeting the consistency criteria in each strata that were useful for characterizing high quality streams by strata. The other 20% of the 1994-97 data was retained for validation as discussed later in the report.

Various metrics were added individually to the core group to determine if the efficiency of the index improved. The index was developed after the maximum efficiency of metrics was determined. Metrics that were not on a 0-20 scale were rescaled to a 0-20 range and all selected metrics were evaluated by logistic regression to determine if weighting of metrics was warranted. For both strata, weighting was determined to be appropriate. Weighting coefficients were assigned that were roughly proportional to the coefficients from the regression (Wang et al., in press).

The final MPHI raw scores from both strata were placed on a 0 to 100 scale using a cumulative distribution function (CDF) of the logistic distribution. This CDF transformation maps each weighted average into its approximate percentile rank in the distribution within each region. The 0 to 100 percentile point system was used in place of the standard 1, 3, and 5 standard scaling system of Karr (see Roth et al., 1998) because it is easier for the public to understand percent and it avoids losing data resolution as all the information in the original score is retained. The 0-100 scoring system has also been endorsed by Minns et al. (1994) for fish IBI scoring. Another constructive reason for using the 0-100 scoring system is that the probability integral transform (Roussas, 1973) used to create the 0-100 scores produces data of a known statistical distribution, the uniform (0,100), which makes it useful for statistical applications.

2.6 Validate the Index

The Coastal and Non-Coastal Plain indices were validated by randomly selecting 80 percent of the 1994-1997 data set as a training set (calibration data set) for development and reserving the remaining 20 percent as an independent validation set. This resampling procedure was repeated 100 times.

There were two objectives for this resampling experiment. One was to determine the efficiency of discrimination between reference and degraded sites when the data used for calibration of the are independent of the data used for validation. The second objective was to determine if any metric other than those meeting the discrimination and consistency criteria established would appear to consistently add discrimination power to the rule in a large majority of these resampling experiments.

To address the question of other metrics, the data were partitioned into an 80/20 split and a logistic regression was run on the 80%. Logistic regression is a tool that is commonly used when the dependent variable is dichotomous (reference/degraded, live/dead, etc) and the independent variable is continuous (Cox, 1970; Ashton, 1972). It is used to estimate the probability that a case falls in one of the two categories as a function of the independent variables. In this application, it was used to estimate the probability that a site was degraded as a function of the metrics that were selected for their discriminating power.

This logistic regression was run in a manner that forced into the model the metrics that had been identified as good consistent discriminators. Other good discriminatory metrics were then added to the model by stepwise selection.

After expanding the set of metrics, the resampling procedure was repeated with the full set being forced into the model. With this full discrimination rule, the percent correct was computed separately for the dependent data (80 percent) and the independent data (20 percent). The percent correct classification was accumulated after resampling 100 times.

2.7 Assess Categories for Final MPHI Scores

The following four categories of final MPHI scores were used: Good, Fair, Poor and Very Poor. These categories correspond with the Fish IBI classification categories used by Roth et al.

(1998). For each metric that was used to compute the MPHI, the 10th and 50th percentile of the reference site data was identified for each strata. Using the MPHI formula for each strata, an $MPHI_{10}$ and $MPHI_{50}$ were computed as functions of the 10th and 50th percentiles, respectively. The $MPHI_{10}$ and $MPHI_{50}$ were transformed to the 0-100 scale using the logistic CDF as described above. The results were consistent across strata and averages were calculated. Categories were then determined as follows based on cutpoints:

$$MPHI_{50} < \text{Good} < 100$$

$$(MPHI_{10} + MPHI_{50})/2 < \text{Fair} \leq MPHI_{50}$$

$$MPHI_{10} < \text{Poor} < (MPHI_{10} + MPHI_{50})/2$$

$$0 < \text{Very Poor} < MPHI_{10}$$

2.8 Additional Tasks

In addition to the various tasks described above, additional analysis were also conducted with the 1994-97 MBSS data to address the issues listed below:

2.8.1 Comparison of MPHI, Fish IBI, Benthic IBI and Stream Characteristics

The final MPHI scores for all sites (1994-97) were compared with the fish IBI scores (Roth et al., 1998), benthic IBI scores (Stribling et al., 1998), stream order and stream volume to determine the difference or similarity of paired sets of the various values. Data from the 1994-97 data set were plotted and positive and negative correlations were determined. For example, the analysis was designed to show how often paired sets of endpoints such as fish and the benthic IBIs agreed by category (Good, Fair, Poor and Very Poor) and site.

2.8.2 Relationship of Herpetofauna Presence/Absence Data with Habitat Metrics

Herpetofauna (salamanders, toads, lizards, turtles, frogs and snakes) have been sampled during the MBSS to assess the diversity of these riparian species and provide an additional measure of assessing environmental stress at non-tidal stream sites (Kazyak, 1997). These herpetofauna data were analysed using a stepwise logistic regression to determine the positive or negative relationship of these data with the various physical habitat metric listed in Table 2.1.

2.8.3 Compare Quality Control Scores with the Three Field Crew

The scoring of physical habitat metrics from the three field crews (WREC, DNR and AL) from 68 sites from 1995-97 were compared with the score of the Quality Control (QC) officer (Paul Kazyak). For each continuous metric and each site, the difference of the QC score minus the crew score was computed. The different scores were analyzed by ANOVA and for each crew the null hypothesis that the crew mean difference score was equal to zero was tested using the LSMEAN statistic (SAS Institute, 1989). In addition, a test for the overall mean difference score (averaged over crews) was computed. A p-value of 0.017 (0.05/3) based on a Bonferroni adjustment was used as a benchmark for determining differences between QC scores and field crew scores. The categorical metrics were analyzed by using a Chi-square method.

2.8.4 Relationship Between Land/use Characteristics and Instream Continuous Habitat Metrics

Stepwise logistic regression was used to compare the land cover metrics in the upper left corner of Table 2.1 (e.g old field, deciduous forest) with the 13 continuous physical habitat metrics. Positive, negative and non significant relationships were determined.

2.8.5 Influence of Habitat Quantity versus Quality on Fish Communities

The objective of this analysis was to determine the influence of stream habitat quantity (volume of area sampled) versus habitat quality (final MPHI scores) on fish abundance (number per square meter), species richness and Fish IBI scores. To assess the relative influence of habitat quantity and habitat quality on the species richness of the fish community, two analyses were conducted for each of the three measures of the fish community. The first analysis employed a regression model where each of the three fish community measures were used as a dependent variable and the independent variables were volume and MPHI. The apparent importance of these two independent variables in the regression equation as measured by the F-statistic is order dependent because there is correlation between our measures of quantity and quality (i.e. results can change depending on which variable is entered first). Therefore, two regressions were employed for each dependent variable. In the first, volume was entered before MPHI and in the second the order was reversed. From these two regressions, we established the unique contribution of volume and MPHI to the prediction of fish community species richness.

The second analysis used a stepwise regression to select among the individual habitat metrics and volume to establish an order of importance in predicting each measure of the fish community. Results from this analysis determined if stream quantity or some dimension of stream quality is most important for determining characteristics of a fish community.

SECTION 3
RESULTS

3.1 Determine Strata

As described previously in the Section 2.1, DNR and the Principal Investigators agreed that the logical partitioning of sites for developing the MPHI should coincide with the strata used for the recently developed fish IBI (Roth et al., 1998). This strata determination was (1) Coastal Plain and (2) Non-Coastal Plain (Appalachian Plateau, Valley and Ridge, Blue Ridge, and Piedmont regions). These two geographic strata are consistent with aggregations of ecoregions (Omenik, 1987) and physiographic provinces developed for Maryland (Reger, 1995).

3.2 Identify Reference and Degraded Sites

Criteria used for selecting reference, degraded and unclassified sites are presented in Section 2.2. For small streams with less than 300 acre watersheds, fish IBI values were not determined; therefore, the number of fish species (species richness) was used as a replacement for the IBI values. Box and Whisker plots of fish species richness values for both Coastal and Non-Coastal Plain streams with less than 300 acre watersheds are presented in Figures 3.1 and 3.2. These plots provide the rationale used for selecting the fish richness criteria of ≥ 5 for reference sites and ≤ 1 for degraded sites. Sites not meeting either of these criteria were unclassified.

Frequencies of reference, degraded and unclassified sites by order for both Coastal and Non-Coastal Plain streams are presented in Table 3.1 and 3.2, respectively. (See Appendix A for individual stream classifications). For the Coastal Plain streams, the greatest number of sites were unclassified (257), followed by degraded (76) and reference (53). An analysis by stream order for

Coastal Plain streams shows that there is a low frequency of degraded 3rd order streams, reference 0 order (< 300 acre watersheds) streams and reference 1st order streams (Table 3.1).

The total number of Non-Coastal Plain streams by category in descending order is unclassified (410), reference (169) and degraded (95). There were only a few 0 order reference streams and a limited number of degraded 3rd order streams (Table 3.2).

3.3 Assess Discriminatory Power of Metrics

Box and Whisker plots for reference and degraded sites by continuous metric and strata (Coastal Plain and Non-Coastal Plain) are presented in Figure 3.3. For both strata, metric scores were consistently higher in reference sites than degraded sites except for shading (a bimodal metric where too much or too little may be adverse), embeddedness (higher scores are associated with degradation) and bank stability (appears to have little discriminatory power). The metrics with the best discriminatory power in separating reference and degraded sites in the Coastal Plain were: instream habitat, epifaunal substrate, maximum depth, aesthetics, embeddedness, pool/glide/eddy quality and velocity/depth diversity. Remoteness, riparian buffer width, shading, channel flow, bank stability and channel alteration had poor discriminatory power in Coastal Plain stream sites. The metrics with the best discriminatory power in separating reference and degraded Non-Coastal Plain sites were: instream habitat, aesthetics, embeddedness, riffle/run quality and velocity/depth diversity. Remoteness, riparian buffer width, shading, bank stability and channel alteration had poor discriminatory power in Non-Coastal Plain stream sites.

Results from Pooled t-test analysis by metric and strata for degraded and reference sites were similar to the Box and Whisker Plots (Table 3.3). From this analysis, the following metrics showed consistently good discriminatory power for both Coastal and Non-Coastal Plain stream sites:

instream habitat, epifaunal substrate, velocity/depth diversity, pool/glide/eddy quality, riffle/run quality, embeddedness and maximum depth. Metrics with consistently poor discriminatory power in both strata were: number of woody debris, bank stability, and riparian buffer width. Metrics with good discriminatory power in the Coastal Plain only were channel alteration, remoteness and aesthetic rating. Number of rootwads, channel flow status and shading showed good discrimination in only Non-Coastal Plain sites (Table 3.3).

Categorical metrics that showed good discriminatory power across both strata were limited to deep pool, gravel, rootwads and undercut banks (Table 3.4; see Table 2.1 for description of these metrics). The categorical metrics residential, shallow pool, concrete and emergent vegetation showed some discriminatory power in Coastal Plain stream sites. Braided streams, riffle and storm drains showed some discriminatory power in Non-Coastal Plain stream sites.

Many of the physical habitat metrics correlated with stream order (Table 3.5). The number of stream category types (reference and degraded) for both strata was unbalanced across stream orders as small streams were more likely to be degraded and larger streams were more likely to have reference conditions (Table 3.5). For Coastal Plain streams, more metrics showed discriminatory power in 2nd order streams than the other three orders. Metrics with high discriminatory power in the Coastal Plain as previously described (instream habitat, velocity/depth diversity, pool/glide/eddy quality, embeddedness, maximum depth and aesthetics) were good discriminators in 2nd order streams and most of the other stream orders as well. For Non-Coastal Plain streams, there was similar discriminatory power for metrics across the 0, 1st and 2nd order streams; lower discriminatory power was reported for 3rd order streams (Table 3.5). Key discriminatory Non-Coastal Plain stream metrics previously identified (instream habitat, velocity/depth diversity, riffle/run quality, embeddedness and aesthetics) appeared to have relatively consistent discriminatory power across stream orders (Table 3.5).

Approximately twice as many metrics showed discriminatory power in the Coastal Plain in 1995 and 1996 compared to 1994 or 1997 (Table 3.6) For the Non-Coastal Plain data, there was fairly consistent discriminatory power of metrics for 1995, 1996 and 1997. However, only three metrics (riffle/run quality, channel flow and aesthetics) showed discriminatory power in 1994 (Perhaps due to a possible training effect since this was the first year of the statewide MBSS or just a small sample size). The results from this yearly analysis provided useful insight for the validation step described later in this report. The original proposed approach was to use the 1994-96 MBSS data for MPHI development and the 1997 data for validation. However, based on the annual variability reported from this analysis we decided to used 80% of all the data randomly selected from 1994-97 for MPHI development and the other 20% for validation.

3.4 Select Core Metrics and Combine into an Index

Principal Components Analysis (PCA) and stepwise discriminant analysis were used to develop provisional indices for each strata (Appendix B). For example, the correlation matrix in Appendix B for continuous metrics in the Coastal Plain showed that the following metrics were good discriminators when assessed individually and were also highly correlated: instream habitat and epifaunal substrate (correlation of 0.87), instream habitat and velocity/depth diversity (correlation of 0.80) and instream habitat and pool quality (correlation of 0.82). However, if a stepwise discriminant procedure chooses one of these paired metrics, it is unlikely to choose the other because of the high correlation between the two. The second metric offers little additional information.

The eigenvalues of the PCA correlation matrix for Coastal Plain sites showed that two principal components have eigenvalues greater than 1. These data also showed that these two principal components explained 76% of the variance from all 10 metrics (Appendix B).

Loading on the eigenvectors for Coastal Plain sites showed how strongly each metric associated with each factor. For example, the following metrics all loaded on principal component 1 with a score > 0.30: instream habitat, epifaunal substrate, velocity/depth diversity, riffle/run quality, embeddedness, maximum depth, and pool quality (Appendix B). All of these metrics are therefore highly correlated (r > 0.72). For principal component 2, remoteness and aesthetics were loaded most heavily for Coastal Plain data.

The correlation matrix for continuous metrics, eigenvalues of the correlation matrix and eigenvectors for Non-Coastal Plain sites are also presented in Appendix B. The correlation between metrics for the Non-Coastal strata was generally weaker than reported for the Coastal Plain. Three principal components have eigenvalues greater than 1 and these three principal components explained 73% of the variance for all 10 principal components. Metrics that were highly correlated and loaded on factor 1 with an score > 0.30 were: instream habitat, velocity/depth diversity, riffle/run quality, maximum depth and pool/glide/eddy quality. Factor 2 was loaded most heavily with epifaunal substrate, embeddedness, channel flow, and shading. Number of rootwads (a core metric later selected for the Non-Coastal strata) loaded most heavily on factor 3 but not on factors 1 and 2.

A provisional version of the MPHI for each strata was developed using the PCA results based on the philosophy that redundancy of metrics is constructive for the reliability of the index. The metrics were grouped according to how they loaded on the PCA components. Metrics in each group were averaged to obtain a canonical variable that represented the group. An index was then computed as a weighted average of the canonical variates. In summary, the index developed by this

PCA method did not perform well with the Coastal Plain data but did yield a satisfactory performance with the Non-Coastal Plain data when validated. Due to this inconsistency, this approach was abandoned in favor of selecting metrics based on consistency of discrimination over stream order and years.

The second type of proposed index assumes that redundancy of metrics is not constructive and therefore chooses the minimal set of metrics needed to maximize discriminatory power. These results, derived by using both stepwise discriminant analysis and stepwise logistic regression, are summarized in Appendix B. The core metrics selected for the Coastal Plain using this discriminant procedure were: instream habitat, aesthetics, maximum depth, emergent vegetation, gravel and sand. Core metrics selected for the Non-Coastal Plain strata were velocity/depth diversity, instream habitat, embeddedness, channel flow, riffle/run quality, undercut banks, storm drains and number of rootwads. Categorical metrics are scored by presence/absence while continuous metrics are on a 0-20 scale; therefore, even though the coefficients for the categorical metrics are large their influence is actually smaller on a per unit basis.

In the final selection of metrics for both strata, the results from the PCA, stepwise discriminant analysis and stepwise logistic regression provided useful insight on the interrelations and discriminatory power of metrics. However, neither the redundancy index or the no-redundancy index worked for both strata when validated against the 1997 data (See Appendix B; for example only 57% classification efficiency was reported for the Coastal Plain redundancy index). Therefore, the analysis presented in Section 3.3 (Assess Discriminatory Power of Metrics) was used as the primary approach for selecting core metrics and developing a physical habitat index for each strata. Metrics had to show consistent discriminatory power across stream orders and years to be selected as core metrics.

The following core metrics were selected for the Coastal Plain Physical Habitat Index: instream habitat, velocity/depth diversity, pool/glide/eddy quality, embeddedness, maximum depth, and aesthetics. For the Non-Coastal Plain strata, the following core metrics were selected: instream habitat, velocity/depth diversity, riffle/run quality, embeddedness, number of rootwads and aesthetics. After identifying the important metrics for each strata, the process of developing the weighted indices involved the following steps:

1) scaling metrics to 0-20;

2) identifying weights using logistic regression;

3) computing raw indices as a weighted combination of metrics; and

4) scaling raw indices to 0-100 scale using logistic cumulative distribution function

The following three metrics were rescaled as shown to place all metrics on more uniform 0-20 scales: maximum depth = maximum depth/5; embeddedness = embeddedness/5 and number of rootwads = number of rootwads x 3. Two logistic regression procedures were considered for deriving the weights that would be used in the raw index equations. One regression procedure is multiple logistic regression which finds a linear combination of the metrics that best discriminates between reference and degraded sites when the metrics are considered as a group. The second regression procedure is a single logistic regressions run for each metric to estimate the coefficient that best discriminates between reference and degraded when metrics are considered individually. When metrics are redundant, the multiple logistic regression tends to place less emphasis on the second of the redundant pair which eliminates the advantages of redundancy. Therefore, weights were chosen as round numbers that were roughly proportional to the single regression coefficients as shown in the tables below for the Coastal Plain and Non-Coastal Plain, respectively. For example, in the Coastal Plain data set instream habitat, velocity/depth/diversity and pool/glide/eddy quality all have regression coefficients within a standard error of approximately 0.22. Embeddedness, maximum depth and aesthetics have coefficients that are within a standard error of 0.11. The second group has coefficients that are roughly one half of those in the first group. Based on this, the groups were assigned weights of 1.0 and 0.5, respectively.

Coastal Plain

Metric	Mult. Reg Parameter Estimate	Single Reg Parameter Estimate	Weight
INSTRHAB	-0.0603	-0.1954	1.0
VEL_DPTH	0.0712	-0.2147	1.0
POOLQUAL	-0.1544	-0.2327	1.0
EMBEDDED	0.1217	0.1157	-0.5
MAXDEPTH	-0.0536	-0.1283	0.5
AESTHET	-0.1296	-0.1008	0.5

Non-Coastal Plain

Metric	Mult Reg Parameter Estimate	Single Reg Parameter Estimate	Weight
INSTRHAB 1	-0.1804	-0.2621	1.0
VEL_DPTH 1	-0.1291	-0.2973	1.0
RIFFQUAL 1	-0.1227	-0.2475	1.0
NUMROOT 1	-0.2168	-0.2406	1.0
EMBEDDED 1	0.1669	0.1424	0.5
AESTHET 1	-0.1404	-0.1058	0.33

After the weights were selected, the following average index values were computed where each metric was multiplied by its weight.

phi_c = (INSTRHAB+VEL/DPTH+POOLQUAL-EMBEDDED/2+MAXDEPTH/2+AESTHET/2)/6
phi_{nc} = (INSTRHAB+VEL/DPTH+RIFFQUAL-EMBEDDED/2+NUMROOT+AESTHET/3)/6

where phi_c is physical habitat index for Coastal Plain and phi_{nc} is the physical habitat index for the Non-Coastal Plain.

The algebraic equations that combined the scaling and the weighting were as follows:

phi_c = (INSTRHAB+VEL/DPTH+POOLQUAL-EMBEDDED/10+MAXDEPTH/10+AESTHET/2)/6

phi_{nc} = (INSTRHAB+VEL/DPTH+RIFFQUAL-EMBEDDED/10+3 x NUMROOT+AESTHET/3)/6

After computing the raw indices for Coastal and Non-Coastal strata, these indices were transformed to a 0-100 scale for cross strata use. The logistic cumulative distribution function for this transformation was as follows:

$$MPHI = \frac{1}{1 + \exp\left(\dfrac{-(phi_c - mnphi_c)}{\beta_c}\right)} \quad \text{if Coastal}$$

$$= \frac{1}{1 + \exp\left(\dfrac{-(phi_{nc} - mnphi_{nc})}{\beta_{nc}}\right)} \quad \text{if Non-Coastal}$$

$$\beta_c = \sqrt{\sigma_c^2 \; x \; \frac{3}{\pi^2}}$$

$$\beta_{nc} = \sqrt{\sigma_{nc}^2 \; x \; \frac{3}{\pi^2}}$$

$mnphi_c$ = 6.0051249 (mean of phi for Coastal)
σ^2_c = 7.5272067 (variance of phi for Coastal)
$mnphi_{nc}$ = 6.8141183 (mean of phi for Non-Coastal)
σ^2_{nc} = 6.0533951 (variance of phi for Non-Coastal)

3.5 Validate the Index

The Coastal and Non-Coastal Plain indices were validated by randomly selecting 80 percent of the 1994-1997 data set as a training set for development and reserving the remaining 20 percent as an independent validation set. This resampling procedure was repeated 100 times.

In 96 of the 100 simulations used for the Coastal Plain data, aesthetics was chosen as the most important metric that would improve discrimination. For these 96 cases, no other metric was chosen. For the 4 cases where aesthetics was not chosen first, ephifaunal substrate was chosen as the most important metric that would improve discrimination, and aesthetics was chosen second. Thus in all 100 simulations aesthetics was chosen. Therefore, aesthetics was added to the list of good discriminators for the Coastal Plain strata.

Using the full set of metrics, the discrimination efficiency for dependent and independent data in the Coastal Plain strata was as follows:

	Degraded	Reference	Total
Dependent	90.8	79.0	85.7
Independent	88.0	75.5	82.5

For the Non-Coastal Plain strata, aesthetics was chosen as the most important metric that would improve discrimination in all cases (100 out of 100 simulations). In 67 out of 100 runs, channel flow was chosen as a second most important variable that would improve discrimination. Thus, for the Non-Coastal strata, aesthetics was added to the list of good discriminators.

The classification efficiencies for Non-Coastal Plain sites were:

	Degraded	Reference	Total
Dependent	73.3	80.3	77.9
Independent	71.4	79.4	76.6

The dependent percent was computed from the 80 percent of the data used to compute each discrimination rule. The independent percent was computed from the 20 percent of the data that was retained for validation. Generally, the classification efficiency was reduced by approximately 2-4 percent for independent data relative to the estimate obtained for dependent data. The final classification efficiency for both strata combined with the rounded weights for various metrics was 76 % as shown below.

OBSERVED PREDICTED

Freq. Row Pct.	Degraded	Reference	Total
Degraded	144 73.10	53 26.90	197
Reference	48 21.62	174 78.38	222
Total	192	227	419

(144 + 174)/419 = 0.76

3.6 Assess Categories for Final MPHI Scores

The four categories of Good, Fair, Poor and Very Poor used for the final MPHI scores corresponded to the fish IBI categories used by Roth et al. (1998). The 10th and 50th percentile values were determined for core metrics taken at reference sites only in each strata as presented in Table 3.7. These centiles were then converted to cutpoints on the 0-100 scale using the MPHI formula. These scaled cutpoints, both $MPHI_{10}$ and $MPHI_{50}$, were similar for the two strata; therefore, we averaged these cutpoints for both strata to determine the following categories:

Good	=	> 72	($MPHI_{50}$	- 100)
Fair	=	42 - 72	($MPHI_{10}$+$MPHI_{50}$)/2	- $MPHI_{50}$)
Poor	=	12 - 42	($MPHI_{10}$	- ($MPHI_{10}$+$MPHI_{50}$)/2)
Very Poor	=	< 12	(0	- $MPHI_{10}$)

Using similar categories in both strata will aid in the application and communication of MPHI results. The frequency by category for Coastal Plain, Non-Coastal Plain and all sites is summarized in Table 3.8. The percent and cumulative percent by category is similar for all three sets of data. There is a higher percentage of Good sites (30 to 32 %) than Very Poor sites (15 to 16%) in all three sets of data. More than half of all the sites are in the Poor to Fair range.

3.7 Additional Tasks

3.7.1 Comparison of MPHI, Fish IBI, Benthic IBI and Stream Characteristics

Pearson Correlation Coefficients were used to show the relationship between paired sets of the following MBSS data from 1994-97: fish IBI scores, 1998 fish IBI score (revised fish IBI scores), benthic IBI scores, MPHI scores, stream order and stream volume (Table 3.9). Results from this analysis showed there are many significant correlations between paired sets of data. As expected, the highest correlation (0.88) was reported between the fish IBI scores and the 1998 fish IBI scores recently updated by Versar (Nancy Roth, personal communication). The 1998 fish IBI scores had a slightly higher correlation (0.52) with the MPHI than the fish IBI (0.46) used for the MPHI development. The benthic IBI had a low correlation with the MPHI and both stream size characteristics. The benthic IBI may therefore be useful as an independent measure of stream quality , particularly for small streams where the fish IBI has limited discriminatory power. The stream size characteristics of volume and order had a correlation of only 0.59 which suggests that they may be measuring different dimensions of the stream. Due to various inconsistencies in assigning stream order during the MBSS, it is highly likely that stream volume is a more accurate measure of stream size than stream order. Both the MPHI and fish IBI correlated with stream size characteristics.

Multiple linear regression analysis was used to determine how well the fish IBI can be predicted by the combination of stream size, MPHI scores and the benthic IBI scores (Table 3.10). The multiple correlation from this analysis was 0.55 (r-square = 0.30). These results show that stream size, MPHI, Benthic IBI all have an independent and significant ($p \leq 0.0001$) influence in predicting fish IBI scores. Both stream volume and stream order were similar in predicting fish IBI scores.

Parallel axes plots were used to demonstrate the relationship among stream volume, MPHI scores, benthic IBI scores, and fish IBI scores (Figures 3.4 and 3.5). All indices were scaled 0 to 100 using a cumulative distribution function. Volume was transformed to a log scale and then rescaled to 0-100. Two figures were used to present both high fish IBI scores (IBI > 80 in Figure 3.4) and low fish IBI scores (IBI < 20 in Figure 3.5) concurrently with the four categories of MPHI scoring (Very Poor, Poor, Fair and Good). For example, in Figure 3.4A the sites with good fish IBI scores on the far right axis (scores >80) have only a few sites where the MPHI scores are very poor (<20). However, in Figure 3.4D there were numerous sites with concurrent high (Good) fish IBI scores and high MPHI scores. Sites with high fish IBI scores often had both high MPHI scores and high benthic IBI scores and rarely were both MPHI scores and benthic IBI scores low in the high fish IBI streams. However, it was not unusual for these high fish IBI streams to also have a high MPHI score and a low benthic IBI score.

For streams with low fish IBI scores, concurrent low benthic IBI and MPHI scores were also common (Figure 3.5). It was rare to have streams with low fish IBI scores and high benthic IBI scores and high MPHI scores. For these low fish IBI streams, high MPHI scores were usually associated with low benthic IBI scores and high benthic IBI scores were usually associated with low MPHI scores.

A significant finding observed for both Figures 3.4 and 3.5 is that larger streams (represented by volume) have higher physical habitat scores and higher fish IBI scores. In contrast, the benthic IBI scores have little relationship to stream size.

3.7.2 Relationship of Herpetofauna Presence/Absence with Habitat Metrics

The geographic distribution of anura (frogs and toads) and caudata (salamanders and newts) differs by physiographic province as shown in Figure 3.6. Salamanders are found more frequently in Non-Coastal Plain strata, primarily in the western part of Maryland. In contrast, frogs and toads are encountered more frequently in the Coastal Plain. In the Piedmont, both anura and caudata occur in a large proportion of stream miles sampled by the MBSS.

The data in Table 3.11 summarizes in descending order the number of sites where 53 herpetofauna species were present. The four species with the highest presence by site were the green frog, Northern two-lined salamander, bullfrog and pickerel frog. Rare species were the smooth green snake, rough green snake, Northern fence lizard and Jefferson salamander (see Table 3.11 for the other rare species). From the logistic regression analysis in Table 3.12 with continuous habitat metrics and stream volumes, a break between 43 and 26 was used as a cutoff (all species above Fowler's toad in Table 3.11). The American toad, mountain dusky salamander and Northern dusky salamander showed the highest number of positive relationships with the various habitat metrics and volume. The green frog, Southern leopard frog and Northern two-lined salamander showed the highest number of negative relationships with the habitat metrics and volume.

Shading, riparian width, and remoteness had the highest number of positive relationships with the various herpetofauna species. There were also strong interrelationships among these three metrics. Shading present at a stream site is a function of riparian width and plant species composition; remote areas also tend to have better riparian habitat. Conversely, those metrics in Table 3.12 more related to channel characteristics (velocity/depth) and flow (channel flow) generally do not strongly affect the presence or absence of herpetofauna. The exception was channel alteration which positively influenced herpetofauna. This metric serves as a surrogate for bank stability and may reflect the presence of suitable bank habitat.

The highest number of negative relationships occurred with embeddedness, volume, bank stability and maximum depth. Since embeddedness is a measure of stream sediment, outside sediment sources from the same habitat used by herpetofauna may indicate significant streamside alteration, resulting in poor habitat for this assemblage of species. Stream volume may well relate to the observation that herpetofauna (especially salamanders and newts) are not common along the larger streams and prefer smaller first order streams.

In general, herpetofauna respond differently to physical habitat metrics than benthos or fish. The physical habitat metrics evaluated during the MBSS were generally more appropriate for assessing relationships between these metrics and instream organisms such as fish and benthos. However, as shown above some of the streamside characteristics (riparian width, shading etc.) did influence the presence of herpetofauna.

3.7.3 Compare Quality Control Scores with the Three Field Crews

A summary of comparisons for continuous physical metrics between the Quality Control (QC) officer (Paul Kazyak) and the three field crews is presented in Table 3.13. This table shows the physical habitat metric, crew, QC officer score, crew score, difference between the crew score and the QC officer score, number of sites and p-value. The p-value should be less that 0.017 to be significant due to multiple comparison adjustments for each metric. The last line for each metric is the mean score for all sites.

The AL and WREC field crew scores generally agree with the QC officer scores for most all the metrics with the exception of one metric for each field crew. The exceptions were bank stability for the AL field crew and rootwads for the WREC crew. There was disagreement between the DNR field crew scoring of habitat metrics and QC officer scoring for the following metrics: instream habitat, pool/glide/eddy quality, riffle/run quality, channel alteration, and shading. The larger number of conflicting metrics reported for the DNR crew may be due to the greater number of sites sampled for quality control comparisons that resulted in increased statisitical power for reporting differences. The mean score by metric for the field crews and the QC officer was only different for the number of rootwads. These results generally show consistent scoring of continuous physical habitat metrics among the field crews. Since all field crews attended a training workshop to insure consistency in measuring physical habitat metrics in the field these results are encouraging

Comparison of categorical metrics in Appendix C generally showed good agreement between the QC officer scores and the field crew scores. The only significant difference occurred with the meandering metric for the DNR field crew (possibility related to sample size).

<u>3.7.4 Relationship between Landuse Characteristics and Instream Continuous Habitat Metrics</u>

A logistic regression was used to determine the relationship between landuse characteristics and instream habitat metrics in Table 2.1. Each land use metric is reported as present or absent (Table 3.14). The land use characteristics surface mine (6 present), landfill (1 present) and orchard-vineyard (4 present) were not included in the analysis because they did not occur in sufficient frequency. The logistic regression assesses the probability of occurrence of the landuse characteristic as a function of the instream habitat metric which is recorded on a continuous scale. A summary of results in Table 3.15 shows each landuse characteristic regressed against each instream habitat metric. Positive, negative and non significant relationships are presented in Table 3.15.

The relationships between the core habitat metrics described earlier in this report for both Coastal and Non-Coastal Plain streams and various land use characteristics generally seem logical. For example, aesthetics was positively correlated with both deciduous forest and coniferous forest and negatively correlated with residential areas. Embeddedness was positively correlated with wetlands (areas with sediment accumulation). Instream habitat was positively correlated with deciduous forest and coniferous forest (minimal human impact) and negatively correlated with commercial/ industrial development, cropland and pasture. Maximum depth was positively correlated with deciduous forest and negatively correlated with cropland and pasture. Pool/glide/eddy quality was negatively correlated with residential areas and cropland. Riffle/run quality and velocity/depth diversity were positively correlated with deciduous forest and negatively correlated with cropland.

For the habitat metrics with less discriminatory power, it is noteworthy that deciduous/coniferous forests positively correlated with bank stability, epifaunal substrate, remoteness, riparian width and shading. Residential and commercial/industrial areas were negatively correlated with remoteness and riparian width.

3.7.5 Influence of Habitat Quantity versus Quality on Fish Communities

Regression analysis and stepwise regression were used to assess the relative contributions of habitat quantity (volume of stream segment sampled) versus habitat quality (MPHI scores) to various components of the fish community (abundance per square meter, number of species and fish IBI scores). In the first type of analysis, a regression model was used where each of the fish community measures was a dependent variable and the independent variables were stream volume and MPHI scores. Because there is a correlation between volume and MPHI scores, the apparent importance of these two independent variables in the regression equation as measured by the F-statistic will be order dependent. Therefore, two regressions were used for each dependent variable. Volume was entered before MPHI scores in the first equation; the order was reversed in the second regression (Table 3.16).

The MPHI (also defined as SMPHI - Scaled Maryland Physical Habitat Index) had the highest correlation with number of species, a lower correlation with the fish IBI scores and the lowest correlation with abundance per square meter (Table 3.17). Volume was also highly correlated with the number of species; a lower correlation was reported with the fish IBI. A negative correlation was reported between volume and abundance per square meter (fish density increased as stream volume decreased). In general, it appears that both volume (habitat quantity) and MPHI (habitat quality) influence various characteristics of the fish community.

In the second type of analysis, stepwise regression was used to select among individual habitat metrics and volume to determine an order of importance in predicting the three measures of the fish community (Tables 3.18, 3.19 and 3.20). Embeddedness was most important, followed by volume, for predicting abundance per square meter (Table 3.18). Important metrics for predicting number of fish species (from most to least important) were: volume, velocity/depth diversity, bank stability, shading, maximum depth, aesthetics and instream habitat (Table 3.19). Velocity/depth diversity, embeddedness, and aesthetics were the three most important predictors for the fish IBI (Table 3.20). In summary, it appears that different physical habitat metrics are important in predicting each of the three measures of fish community but stream volume was the single most consistent and influential variable for all three measures.

SECTION 4
SUMMARY

The results from this study are summarized as follows:

- The two geographical strata used to develop and validate a provisional physical habitat index in Maryland non-tidal streams were Coastal Plain (386 sites) and Non-Coastal Plain (674 sites in the Appalachian Plateau, Valley and Ridge, Blue Ridge and Piedmont physiographic regions).
- For both strata, there was a lower frequency of small reference streams (1st order) and larger degraded (3rd order) streams. Many of the physical habitat metrics used in this analysis such as instream habitat, velocity/depth/diversity, pool/glide/eddy quality, embeddedness, maximum depth and riffle/run quality correlated with watershed size.
- The provisional index that assumes redundancy of metrics is efficient (e.g. include two metrics even if they give similar information) performed best with the Non-Coastal Plain data. In contrast, the index that assumed redundancy was inefficient and selected only the best discriminatory metrics preformed best with the Coastal Plain data. Due to this inconsistency, final core metrics for each strata were selected based on their ability to discriminate between reference and degraded sites across stream orders and years.
- Physical habitat metrics with the best discriminatory power for Coastal Plain sites were: instream habitat, velocity/depth diversity, pool/glide/eddy quality, embeddedness, maximum depth and aesthetic rating. The final index calculations for the Coastal Plain weighted all metrics equally except embeddedness, maximum depth and aesthetics which were weighted ½. The final raw equation used the Coastal Plain Physical Habitat Index (CPPHI) was: CPPHI = (instream habitat + velocity/ depth diversity + pool/glide/eddy quality -

embeddedness/10 + maximum depth/10 + aesthetics/2)/6.

- Physical habitat metrics with the best discriminatory power for Non-Coastal Plain sites were: instream habitat, velocity/depth diversity, riffle/run quality, embeddedness, number of rootwads and aesthetic rating. All of these metrics were weighted equally except embeddedness (weighted ½) and aesthetics (weighted $^1/_3$). The final equation used for the Non-Coastal Plain Physical Habitat Index (NCPPHI) was: NCPPHI = (instream habitat + velocity/depth diversity + riffle/run quality - embeddedness/10 + 3 x number of rootwads + aesthetics/3)/6.
- Instream habitat, velocity/depth diversity, embeddedness and aesthetics were four metrics that discriminated well in both strata.
- The overall classification efficiency (correct designation of degraded and reference sites) for indices validation was 76% for both indices pooled over both strata.
- Scaled MPHI values (0-100) for both strata showed that there were nearly twice as many Good sites as Very Poor sites but more than half the sites were in the Poor to Fair range.
- A comparison of MPHI, Fish IBI scores, Benthic IBI scores and stream size characteristics (order and volume) showed that both the MPHI and Fish IBI correlated with stream size characteristics. The Benthic IBI had a low correlation with the MPHI and stream size characteristics and may therefore be useful as an independent measure of stream quality, particularly in small streams. MPHI, Benthic IBI and stream size characteristics all affected Fish IBI scores. Larger streams were reported to have higher MPHI and Fish IBI scores ;however, stream size had little relationship to Benthic IBI scores.
- Remoteness, riparian width and shading had the highest number of positive relationships with the various herpetofaunal species. The highest number of negative relationships

occurred with volume, embeddedness, bank stability and maximum depth.

- Comparison of habitat metric scoring between a Quality Control Officer and three different field crews (AL, WREC and DNR) generally showed good agreement.
- The relationship between the core habitat metrics and various land use characteristics generally seemed logical. For example, aesthetics was positively correlated with both deciduous forest and coniferous forest and negatively correlated with residential areas. Embeddedness was positively correlated with wetlands (areas with sediment accumulation). Instream habitat was positively correlated with deciduous forest and coniferous forest (minimal human impact) and negatively correlated with commercial/ industrial development, cropland and pasture. For the habitat metrics with less discriminatory power, it was noteworthy that deciduous/coniferous forests positively correlated with bank stability, epifaunal substrate, remoteness, riparian width and shading. Residential and commercial/industrial areas were negatively correlated with remoteness and riparian width.
- Both volume (habitat quantity) and MPHI (habitat quality) influenced various characteristics of the fish community such as abundance per square meter, species richness and Fish IBI scores. Various physical habitat metrics are important in predicting the three measures of fish community but volume was the single most consistent and influential variable for all three measures.

SECTION 5
REFERENCES

Ashton, W. D. 1972. *The Logit Transformation*. Griffin Press. London.

Barbour, M. T. and J. B. Stribling. 1991. Use of habitat assessment in evaluating the biological integrity of stream communities. In: Biological Criteria: Research and Regulation, 25-38. U. S. Environmental Protection Agency Report 440/5-91-005, Washington, D. C.

Binns, N. A. 1979. A habitat quality index for Wyoming trout streams. Fish. Res. Rep. Monogr. Ser. No. Wyoming Game and Fish Department, Cheyenne, WY.

Cox, D. R. 1970. *Analysis of Binary Data*. Chapman and Hall Press, London.

Gorman, O. T. and J. R. Karr. 1978. Habitat structure and stream fish communities. Ecology. 59: 507-515.

Karr, J. R. 1981. Assessment of biotic integrity using fish communities. Fisheries 6: 21-27.

Karr, J. R., K. D. Fausch, P. L. Angermeier, P. R. Yant and I. J. Schlosser. 1986. Assessing biological integrity in running waters: A method and its rationale. Illinois Natural History Survey Special Publication Number Five.

Kazyak, P. F. 1997. Maryland Biological Stream Survey Sampling Manual. Maryland Department of Natural Resources, Monitoring and Non-Tidal Assessment Division, Annapolis, Maryland.

Maddock, I. 1999. The importance of physical habitat assessment for evaluating river health. Freshwater Biology 41: 373-391.

Minns, C. K., V. W. Carins, R. G. Randell and J. E. Moore. 1994. An index of biotic integrity (IBI) for fish assemblages in the littorial zone of Great Lakes areas of concern. Can. J. Fish. Sci. 51: 1804-1822.

Omernik, J. M. 1987. Ecoregions of the conterminous United States. Annals of the Association of American Geographers 77: 118-125.

Plafkin, J. L, M. T. Barbour, K. D. Porter, S. K. Gross and R. M. Hughes. 1989. Rapid bioassessment protocols for use in streams and rivers: Benthic macroinvertebrates and fish. U. S. EPA Report EPA/440/4-89/001, Washington, D. C.

Platts, W. S. 1976. Validity of methodologies to document stream environments for evaluating fishery conditions. Pages 267-284 In *Instream Flow Needs Procedures*, Volume Two, American Fisheries Society, Bethesda, Maryland.

Platts, W. S., W. F. Megahan, G. W. Minshall. 1983. Methods for evaluation of stream riparian and biotic conditions. General Technical Report INT-138, U. S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station, Ogden, UT.

Rankin, E. T. 1989. The qualitative habitat evaluation index (QHEI); Rationale, methods and application. Ohio EPA, Columbus, Ohio.

Reger, J. 1995. Memorandum from J. Reger, Maryland Geological Survey, Environmental Geology and Minerals Resources, to J. Perdue, A. Raspberry and E. Bradley. Digital files and metadata for draft physiographic map of Maryland. July 14, 1995.

Roth, N. E., M. T. Southerland, G. Mercurio, J. C. Chaillou, D. G. Heimbuch and J. C. Seibel. 1999. State of the Streams: 1995-1997 Maryland Biological Stream Survey Results. Draft report. Versar Inc., Columbia, Maryland.

Roth, N. E., M. T. Southerland, S. B. Weisberg, J. Chaillou, P. F. Kazyak, S. Stranko, R. J. Klauda, L. W. Hall, Jr. and R. P. Morgan, II. 1998. Development and evaluation of a fish index of biotic integrity for Maryland freshwater streams. Environ. Monitor. Assess. 51: 89-106.

Roussas, G. G. 1973. *A First Course in Mathematical Statistics*. Addison-Wesley. Reading, MA.

SAS Institute, Inc. 1989. SAS/STAT users guide, version 6, fourth edition, volume 1. SAS Institute, Cary, North Carolina.

Simon, T. P. 1999. Introduction: Biological integrity and the use of ecological health concepts for application to water resource characterization. Pages 2-16 In T. P. Simon (ed.) *Assessing the Sustainability of Biological Integrity of Water Resources Using Fish Communities.* CRC Press, Boca Raton, Florida.

Stribling, J. B., J. S. White, B. J. Jessup, D. Boward and M. Hurd. 1998. Development of a benthic index of biotic integrity for Maryland streams. Tetra Tech Inc. Owings, Maryland.

Van Deusen, R. D. 1954. Maryland freshwater stream classifications by watersheds. State of Maryland, Board of Natural Resources, Department of Research and Education, Chesapeake Biological Laboratory, Solomons, Maryland.

Wang, L., J. Lyons and P. Kanehl. in press. Development and evaluation of a habitat rating system for low gradient Wisconsin streams. North American J. Fish. Manag.

Yoder, C. O. and M. A. Smith. 1999. Using fish assemblages in a state biological assessment and critical program: Essential concepts and considerations. Pages 17-56 In T. P. Simon (ed.) *Assessing the Sustainability and Biological Integrity of Water Resources Using Fish Communities.* CRC Press, Boca Raton, Florida.

TABLES

Table 2.1 MBSS physical habitat assessment data sheet.

MBSS STREAM HABITAT ASSESSMENT DATA SHEET

Page ☐ of ☐

SAMPLE SEGMENT County ☐☐ – Region ☐ – Reach ID ☐☐☐ – Segment ☐☐☐

Reviewed by: ____________

2nd Reviewer: ____________

BASIN ☐☐ (see back for codes)

DATE Year ☐☐ Month ☐☐ Day ☐☐

CREW: ____________________

TIME ☐☐☐☐ (Military)

STREAM:

LANDUSE

- ☐ Old Field
- ☐ Deciduous Forest
- ☐ Coniferous Forest
- ☐ Wetland
- ☐ Surface Mine
- ☐ Landfill
- ☐ Residential
- ☐ Commercial/Industrial
- ☐ Cropland
- ☐ Pasture
- ☐ Orchard/Vineyard/Nursery

STREAM CHARACTER

- ☐ Meandering
- ☐ Braided
- ☐ Channelized
- ☐ Straight
- ☐ Riffle
- ☐ Run/Glide
- ☐ Deep Pool >=.5m
- ☐ Shallow Pool ,.5m
- ☐ Boulder>2m
- ☐ Boulder <2m
- ☐ Cobble
- ☐ Bedrock
- ☐ Gravel
- ☐ Sand
- ☐ Silt/Clay
- ☐ Concrete/Gabion
- ☐ Rootwad
- ☐ Undercut Bank
- ☐ Overhead Cover
- ☐ Human Refuse
- ☐ Emergent Vegetation
- ☐ Submergent Vegetation
- ☐ Floating Vegetation
- ☐ Storm Drain
- ☐ Effluent Discharge
- ☐ Beaver Pond

☐ No. of Woody Debris

☐ No. of Rootwads

HABITAT ASSESSMENT

1. Instream Habitat (0-20).............. ☐☐
2. Epifaunal Substrate (0-20).......... ☐☐
3. Velocity/Depth Diversity (0-20).... ☐☐
4. Pool/Glide/Eddy Quality (0-20).... ☐☐
5. Riffle/Run Quality (0-20)............ ☐☐
6. Channel Alteration (0-20)........... ☐☐
7. Bank Stability (0-20)................. ☐☐
8. Embeddedness (%)................ ☐☐☐
9. Channel Flow Status (%)........ ☐☐☐
10. Shading (%)........................ ☐☐☐
11. Riparian Buffer Zone Width (m).... ☐☐

    Buffer Type (see back)........... ☐☐

    Adjacent Land Cover (see back). ☐☐
12. Remoteness (0-20).................. ☐☐
13. Aesthetic Rating (0-20)............ ☐☐

Maximum Depth (cm) ☐☐☐

Wetted Width (m)	Thalweg Depth (cm)	Thalweg Velocity (m/s)
0m		
25m		
50m		
75m		

Overbank Flood Height (m) ☐.☐

FLOW

Lat Loc(m)	Depth(cm)	Velocity (m/s)

Alternative Flow Measurements

Distance (1m)

Depth (cm) ☐

Width (cm) ☐☐

Time (sec) 1. ☐☐☐

2. ☐☐☐

3. ☐☐☐

Stream Gradient (%) ☐.☐☐

Straight Line Segment Length (m) ☐☐

Stream Block Ht. (m) ☐.☐

Stream Block Type ☐☐

Lat ☐☐ deg ☐☐ min ☐☐ sec

Lon ☐☐ deg ☐☐ min ☐☐ sec

COMMENTS ____________________

Table 3.1 Frequencies of coastal plain streams (1994-97) by stream order. Note that "0" order streams are < 300 acres. D = Degraded, R = Reference, U = Unclassified.

	ORDER				
CLASS	0	1	2	3	TOTAL
D	20	32	22	2	76
R	3	4	27	19	53
U	25	78	78	76	257
TOTAL	48	114	127	97	386

Table 3.2 Frequencies of non-coastal plain streams (1994-97) by stream order. Note that "0" order streams are <300 acres. D = Degraded, R = Reference, U = Unclassified.

	ORDER				
CLASS	0	1	2	3	TOTAL
D	37	27	20	11	95
R	3	20	72	74	169
U	42	109	142	117	410
TOTAL	82	156	234	202	674

Table 3.3 Pooled t-test results for each continuous metric by strata.

Metric	Strata	Pr>|t|	Mean degraded	Mean reference	
No. of Woody Debris	C	0.0134	2.9761	5.0000	
	NC	0.2054	1.6625	2.2129	
No. of Rootwads	C	0.2200	1.5000	2.3478	
	NC	0.0001	0.3235	1.6571	*
Instream Habitat	C	0.0001	6.4418	13.333	*
	NC	0.0001	9.6000	15.046	*
Epifaunal Substrate	C	0.0001	4.7674	10.633	*
	NC	0.0001	8.6750	12.435	*
Velocity/Depth Diversity	C	0.0001	6.3023	12.033	*
	NC	0.0001	8.0875	13.398	*
Pool/Glide/Eddy Quality	C	0.0001	6.3023	12.800	*
	NC	0.0001	9.5750	14.379	*
Riffle/Run Quality	C	0.0001	6.8604	11.700	*
	NC	0.0001	8.4625	14.314	*
Channel Alteration	C	0.0010	6.3720	10.100	*
	NC	0.0118	10.137	12.064	
Bank Stability	C	0.4387	9.5813	10.500	
	NC	0.9213	12.412	12.342	
Embeddedness	C	0.0001	84.069	50.933	*
	NC	0.0001	57.750	38.555	*
Channel Flow Status	C	0.0930	67.674	76.900	
	NC	0.0001	65.175	86.842	*
Shading	C	0.9330	70.372	70.866	
	NC	0.0022	76.862	66.453	*
Riparian Buffer Width	C	0.2053	26.441	33.166	
	NC	0.3551	21.625	24.759	
Remoteness Rating	C	0.0041	7.8372	11.933	*
	NC	0.8441	9.1750	9.3425	
Aesthetic Rating	C	0.0004	9.4186	14.400	*
	NC	0.0221	11.900	13.675	
Maximum Depth	C	0.0001	36.581	78.275	*
	NC	0.0001	41.625	70.055	*

* P<0.01

Table 3.4. The results of Chi-square analysis of categorical metrics for each strata.

Metric	Strata	p - value	pct of degraded	pct of reference	
CLASS BY OLD_FLD	C	0.156	2.33	10.00	
	NC	0.013	10.00	24.07	
CLASS BY DEC_FOR	C	0.215	79.07	90.00	
	NC	0.201	81.25	87.96	
CLASS BY CONI_FOR	C		0.00	0.00	
	NC	0.889	15.00	15.74	
CLASS BY WETLAND	C	0.750	13.95	16.67	
	NC	0.981	7.50	7.41	
CLASS BY RESIDENT	C	0.001	44.19	6.67	*
	NC	0.037	22.50	12.96	
CLASS BY COMM_IND	C	0.321	9.30	3.33	
	NC	0.037	10.00	2.78	
CLASS BY CROPLAND	C	0.373	4.65	10.00	
	NC	0.155	12.50	6.48	
CLASS BY PASTURE	C	0.358	2.33	6.67	
	NC	0.344	15.00	20.37	
CLASS BY ORCH_VIN	C		0.00	0.00	
	NC	0.830	1.25	0.93	
CLASS BY MEANDER	C	0.655	58.14	63.33	
	NC	0.701	32.50	35.19	
CLASS BY BRAIDED	C	0.192	6.98	16.67	
	NC	0.006	5.00	18.52	*
CLASS BY CHANNEL	C	0.145	23.26	10.00	
	NC	0.120	23.75	14.81	
CLASS BY STRAIGHT	C	0.302	41.86	30.00	
	NC	0.347	60.00	66.67	
CLASS BY RIFFLE	C	0.023	58.14	83.33	
	NC	0.005	86.25	97.22	*
CLASS BY RUN_GLID	C	0.001	46.51	93.33	*
	NC	0.001	67.50	99.07	
CLASS BY DEEPPOOL	C	0.001	23.26	63.33	*
	NC	0.001	22.50	63.89	*

Table 3.4 - Continued

Metric	Strata	p - value	pct of degraded	pct of reference	
CLASS BY SHALPOOL	C	0.008	41.86	73.33	*
	NC	0.238	86.25	79.63	
CLASS BY BOULDGT2	C	0.538	11.63	16.67	
	NC	0.656	25.00	22.22	
CLASS BY BOULDLT2	C	0.623	18.60	23.33	
	NC	0.214	68.75	76.85	
CLASS BY COBBLE	C	0.112	25.58	43.33	
	NC	0.037	90.00	97.22	
CLASS BY BEDROCK	C	0.184	4.65	13.33	
	NC	0.547	33.75	29.63	
CLASS BY GRAVEL	C	0.001	39.53	96.67	*
	NC	0.009	91.25	99.07	*
CLASS BY SAND	C	0.051	81.40	96.67	
	NC	0.058	80.00	89.81	
CLASS BY SILTCLAY	C	0.882	81.40	80.00	
	NC	0.095	85.00	92.59	
CLASS BY CONCRETE	C	0.001	30.23	0.00	*
	NC	0.016	16.25	5.56	
CLASS BY ROOTWAD	C	0.001	34.88	80.00	*
	NC	0.001	23.75	56.48	*
CLASS BY UNDCTBNK	C	0.001	16.28	63.33	*
	NC	0.001	38.75	72.22	*
CLASS BY OH_COVER	C	0.917	74.42	73.33	
	NC	0.343	73.75	79.63	
CLASS BY H_REFUSE	C	0.184	55.81	40.00	
	NC	0.091	57.50	69.44	
CLASS BY EMER_VEG	C	0.003	4.65	30.00	*
	NC	0.669	5.00	6.48	
CLASS BY SUBM_VEG	C	0.098	11.63	26.67	
	NC	0.768	3.75	4.63	
CLASS BY FLOATVEG	C	0.400	2.33	0.00	
	NC	0.761	2.50	1.85	

Table 3.4 - Continued

Metric	Strata	p - value	pct of degraded	pct of reference
CLASS BY STORMDRN	C	0.031	20.93	3.33
	NC	0.003	12.50	1.85 *
CLASS BY EFF_DIS	C	0.086	0.00	6.67
	NC	0.708	3.75	2.78
CLASS BY BEAVPOND	C	0.228	0.00	3.33
	NC	0.221	0.00	1.85
CLASS BY BUFF_TYP	C	0.086	more than 2 classes	
	NC	0.450		
CLASS BY ADJ_COVR	C	0.020	more than 2 classes	
	NC	0.190		

* P < 0.01

Table 3.5 Summary of results from the consistency over stream order analysis for discrimination between reference and degraded streams for each of the continuous metrics by strata. Note that 0 order streams have less than 300 acre watersheds.

	Coastal Plain stream order				Non-Coastal Plain stream order			
Metric	0	1	2	3	0	1	2	3
WOOD_DEB			+	*	!			
NUMROOT					+		+	+
INSTRHAB			!		!	!	!	
EPI_SUB						*		!
VEL_DPTH	+	+	*		!	!	!	
POOLQUAL			!		!	*	!	
RIFFQUAL					*	!	!	!
CHAN_ALT					+	+		
BANKSTAB			+				*	
EMBEDDED	*	+	+			*	*	!
CH_FLOW							!	
SHADING				*				
RIP_WID				+	+	*		
REMOTE						*		
AESTHET		*	!			*		!
MAXDEPTH	+		!	*	+		!	
Sample Size								
Reference	3	4	27	19	3	20	72	74
Degraded	20	32	22	15	37	27	20	24

+ = p<= 0.1
* = p<= 0.05
! = p<= 0.01

3.6 Summary of results from the consistency over years analysis for discrimination between reference and degraded streams for each of the continuous metrics by strata.

	Coastal Plain year				Non-Coastal Plain year			
Metric	94	95	96	97	94	95	96	97
WOOD_DEB		*						
NUMROOT							!	+
INSTRHAB	*	!	!	+		!	!	*
EPI_SUB		+	!			!	!	!
VEL_DPTH	+	!	!	!		!	!	!
POOLQUAL	!	*	+	!		!	!	!
RIFFQUAL			!		!	!	!	!
CHAN_ALT	+		!				+	
BANKSTAB								+
EMBEDDED		!	!			!	!	
CH_FLOW					*	!	!	+
SHADING				+				
RIP_WID			*					*
REMOTE		*						+
AESTHET		!	!		*		!	!
MAXDEPTH	!	+		!		!	!	!
Sample Size								
Reference	7	15	8	23	3	27	78	61
Degraded	31	9	7	42	14	28	50	16

+ = p<= 0.1
* = p<= 0.05
! = p<= 0.01

Table 3.7. Cutpoints computed for using the MPHI formula for the habitat index with the 10th and 50th centiles for each coastal plain and non-coastal plain habitat metric.

Coastal Plain

metric	10th centile	50th centile
INSTRHAB	7	12
VEL_DPTH	6	11
POOLQUAL	8	13
EMBEDDED	20 *	12
MAXDEPTH	8.8	13.8
AESTHET	7	15
raw cutpoints	3.15	7.4
scaled cutpoints	13.15	71.55

Non-Coastal Plain

metric	10th centile	50th centile
INSTRHAB	10	16
VEL_DPTH	9	13
RIFFQUAL	8	15
EMBEDDED	13 *	6
NUMROOT	0	3
AESTHET	9	15
raw cutpoints	3.92	8.17
scaled cutpoints	10.57	73.05

* the 90th centile is used for embeddedness because of its inverse relation to the habitat metric.

Table 3.8. Frequency of MPHI categories for coastal plain, non-coastal plain and all sites.

Coastal Plain

Category	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Very Poor	56	14.5	56	14.5
Poor	108	27.9	164	42.4
Fair	99	25.6	263	68.0
Good	124	32.0	387	100.0

Non-coastal plain

Category	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Very Poor	115	16.1	115	16.1
Poor	163	22.8	278	38.9
Fair	221	30.9	499	69.8
Good	216	30.2	715	100.0

All sites

Category	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Very Poor	171	15.5	171	15.5
Poor	271	24.6	442	40.1
Fair	320	29.0	762	69.1
Good	340	30.9	1102	100.0

Table 3.9. Pearson Correlation Coefficients for fish IBI scores, 98 fish IBI scores, benthic IBI scores, MPHI scores, stream order and stream volume. P-values and sample size are reported.

	FISHIBI	BENTHICIBI	MPHI	FIBI_98	ORDER	VOLUME
FISHIBI	1.00000	0.33367	0.45753	0.87928	0.30835	0.25775
	0.0	0.0001	0.0001	0.0001	0.0001	0.0001
	816	815	769	802	816	815
BENTHICIBI	0.33367	1.00000	0.14673	0.32906	0.11861	-0.04628
	0.0001	0.0	0.0001	0.0001	0.0002	0.1614
	815	970	867	806	969	917
MPHI	0.45753	0.14673	1.00000	0.51713	0.47086	0.43980
	0.0001	0.0001	0.0	0.0001	0.0001	0.0001
	769	867	868	770	868	867
FIBI_98	0.87928	0.32906	0.51713	1.00000	0.29007	0.27412
	0.0001	0.0001	0.0001	0.0	0.0001	0.0001
	802	806	770	807	807	806
ORDER	0.30835	0.11861	0.47086	0.29007	1.00000	0.59475
	0.0001	0.0002	0.0001	0.0001	0.0	0.0001
	816	969	868	807	1255	918
VOLUME	0.25775	-0.04628	0.43980	0.27412	0.59475	1.00000
	0.0001	0.1614	0.0001	0.0001	0.0001	0.0
	815	917	867	806	918	919

Table 3.10. Multiple Linear Regression analysis for determining how well the fish IBI can be predicted by the combination of stream size, MPHI and the benthic IBI.

Dependent Variable: FISHIBI

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	252.6196600	84.2065533	111.28	0.0001
Error	763	577.3876738	0.7567335		
Corrected Total	766	830.0073338			

R-Square	C.V.	Root MSE	FISHIBI Mean
0.304358	24.76676	0.869904	3.512386

Source	DF	Type I SS	Mean Square	F Value	Pr > F
VOLUME	1	57.0593458	57.0593458	75.40	0.0001
MPHI	1	121.4585935	121.4585935	160.50	0.0001
BENTHICIBI	1	74.1017207	74.1017207	97.92	0.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
VOLUME	1	14.78130282	14.78130282	19.53	0.0001
MPHI	1	89.17680577	89.17680577	117.84	0.0001
BENTHICIBI	1	74.10172069	74.10172069	97.92	0.0001

Parameter	Estimate	T for H0: Parameter=0	Pr > |T|	Std Error of Estimate
INTERCEPT	1.656052535	14.51	0.0001	0.11410116
VOLUME	0.000901079	4.42	0.0001	0.00020388
MPHI	0.013400946	10.86	0.0001	0.00123447
BENTHICIBI	0.329552172	9.90	0.0001	0.03330286

Table 3.11 Herpetofauna presence by site in descending order.

OBS	TAXA	Number of sites
1	GREEN FROG	404
2	NORTHERN TWO-LINED SALAMANDER	369
3	BULLFROG	301
4	PICKEREL FROG	233
5	NORTHERN DUSKY SALAMANDER	189
6	NONE	114
7	AMERICAN TOAD	103
8	NORTHERN WATER SNAKE	97
9	EASTERN BOX TURTLE	86
10	RED SALAMANDER	78
11	COMMON SNAPPING TURTLE	77
12	MOUNTAIN DUSKY SALAMANDER	48
13	WOOD FROG	48
14	REDBACK SALAMANDER	47
15	SOUTHERN LEOPARD FROG	47
16	FOWLER'S TOAD	43
17	FROG (UNKNOWN)	26
18	COMMON MUSK TURTLE	22
19	EASTERN PAINTED TURTLE	20
20	NORTHERN SLIMY SALAMANDER	20
21	BLACK RAT SNAKE	19
22	NORTHERN SPRING SALAMANDER	19
23	SEAL SALAMANDER	18
24	NORTHERN LEOPARD FROG	17
25	SALAMANDER (UNKNOWN)	17
26	LONGTAIL SALAMANDER	15
27	EASTERN MUD SALAMANDER	13
28	RED SPOTTED NEWT	12
29	EASTERN GARTER SNAKE	11
30	NORTHERN RINGNECK SNAKE	11
31	NORTHERN CRICKET FROG	9
32	FIVE-LINED SKINK	8
33	NORTHERN SPRING PEEPER	8
34	RANID FROG (UNKNOWN)	7
35	NORTHERN BLACK RACER	5
36	QUEEN SNAKE	4
37	WOOD TURTLE	4
38	EASTERN WORM SNAKE	3
39	SPOTTED TURTLE	3
40	TOAD (UNKNOWN)	3
41	EASTERN MUD TURTLE	2
42	MARBLED SALAMANDER	2
43	NORTHERN COPPERHEAD	2
44	PLETHODONTID SALAMANDER (UNKNOWN)	2
45	EASTERN SMOOTH EARTH SNAKE	1
46	EASTERN SPADEFOOT TOAD	1
47	GRAY TREEFROG	1
48	GREEN TREEFROG	1
49	HYLID FROG (UNKNOWN)	1
50	JEFFERSON SALAMANDER	1
51	NORTHERN FENCE LIZARD	1
52	ROUGH GREEN SNAKE	1
53	SMOOTH GREEN SNAKE	1

Table 3.12. Correlation analysis used to determine the relationship of herpetofauna data with habitat metrics and volume. Relationships are positive (+), negative (-) and not significant (.) (p>0.05).

TAXA	INSTRHAB	EPI-SUB	VEL-DPTH	POOLQUAL	RIFFQUAL	CHAN-ALT	BANKSTAB	EMBEDDED	CH-FLOW	SHADING	RIP-WID	REMOTE	AESTHET	MAXDEPTH	VOLUME	TOTAL (+)	TOTAL (-)
AMERICAN TOAD	+	+	+	+	+	+	.	-	+	+	.	+	.	+	+	**10**	**1**
BULLFROG	.	.	.	+	.	-	.	+	.	.	+	+	.	+	.	**5**	**1**
COMMON SNAPPING TURTLE	.	.	.	+	.	.	.	.	.	-	.	.	.	.	+	**2**	**1**
EASTERN BOX TURTLE	.	.	.	.	.	.	-	.	.	+	+	+	.	+	.	**4**	**1**
FOWLER'S TOAD	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	**1**	**0**
GREEN FROG	-	-	-	-	-	-	-	+	.	.	+	+	+	.	-	**4**	**8**
MOUNTAIN DUSKY	+	+	.	.	.	+	+	.	-	.	+	+	+	-	-	**7**	**3**
SALAMANDER	.	-	.	.	.	-	.	.	+	-	-	-	-	.	+	**2**	**6**
NONE	.	+	.	-	.	+	+	-	-	+	+	+	+	-	-	**7**	**5**
NORTHERN DUSKY	+	+	.	.	+	+	-	-	.	+	-	-	.	-	-	**5**	**6**
SALAMANDER	+	.	.	.	.	.	.	-	.	-	.	-	.	.	.	**1**	**3**
NORTHERN TWO-LINED	.	.	.	.	.	.	-	.	.	.	+	+	+	+	.	**4**	**1**
SALAMANDER	.	.	.	-	.	+	.	-	.	+	.	.	+	-	-	**3**	**4**
NORTHERN WATER SNAKE	+	+	.	.	+	+	.	-	.	+	.	.	.	-	.	**5**	**2**
PICKEREL FROG	-	-	-	-	-	-	.	+	-	.	.	.	.	.	-	**1**	**8**
RED SALAMANDER	.	.	.	.	.	.	-	.	.	+	+	+	.	.	.	**3**	**0**
REDBACK SALAMANDER																	
SOUTHERN LEOPARD FROG	**5**	**5**	**1**	**3**	**3**	**6**	**2**	**3**	**1**	**7**	**7**	**8**	**5**	**4**	**4**		
WOOD FROG	**2**	**3**	**2**	**4**	**2**	**4**	**5**	**6**	**3**	**3**	**2**	**3**	**1**	**5**	**6**		
TOTAL # (+)																	
TOTAL # (-)																	

Table 3.13. Summary of comparisons between field crew scores and the QC officer scores for the continuous habitat metrics. Scores are shown for individual crews and for the mean of all crews. AL = Appalachian Laboratory, DNR = Department of Natural Resources and WREC = Wye Research and Education Center.

Metric	Crew	QC officer Score	Crew Score	difference	N	p-value
WOOD_DEB	AL	1.33	1.28	0.06	18	0.9276
	DNR	3.54	3.57	-0.14	35	0.7446
	WREC	10.46	8.92	1.54	13	0.0356
	MEAN	4.30	3.99	0.24	66	0.1665
NUMROOT	AL	1.44	0.83	0.61	18	0.2290
	DNR	2.06	1.70	0.31	35	0.3870
	WREC	3.92	2.46	1.46	13	0.0163*
	MEAN	2.26	1.62	0.62	66	0.0070*
INSTRHAB	AL	13.17	13.56	-0.39	18	0.5460
	DNR	10.08	11.35	-1.27	37	0.0060*
	WREC	12.69	13.00	-0.31	13	0.6845
	MEAN	11.40	12.25	-0.85	68	0.0747
EPI_SUB	AL	10.56	11.22	-0.67	18	0.3550
	DNR	9.49	11.41	-1.92	37	0.0003
	WREC	11.77	12.00	-0.23	13	0.7849
	MEAN	10.21	11.47	-1.26	68	0.0233
VEL_DPTH	AL	11.22	11.11	0.11	18	0.8164
	DNR	11.46	11.62	-0.16	37	0.6274
	WREC	12.62	13.00	-0.38	13	0.4954
	MEAN	11.62	11.75	-0.13	68	0.5915
POOLQUAL	AL	12.11	12.39	-0.28	18	0.6904
	DNR	11.57	13.30	-1.73	37	0.0007*
	WREC	13.23	13.15	0.08	13	0.9253
	MEAN	12.03	13.03	-1.00	68	0.1056
RIFFQUAL	AL	11.44	11.17	0.28	18	0.7173
	DNR	9.24	10.59	-1.35	37	0.0136*
	WREC	14.46	15.15	-0.69	13	0.4440
	MEAN	10.82	11.62	-0.79	68	0.1772

Table 3.13. Continued

Metric	Crew	QC officer Score	Crew Score	difference	N	p-value
CHAN_ALT	AL	10.72	13.11	-2.39	18	0.0193
	DNR	7.59	10.46	-2.86	37	0.0001*
	WREC	8.31	9.08	-0.77	13	0.5136
	MEAN	8.56	10.90	-2.34	68	0.0007*
BANKSTAB	AL	9.50	11.28	-1.78	18	0.0074*
	DNR	8.95	9.22	-0.27	37	0.5491
	WREC	10.15	11.15	-1.00	13	0.1912
	MEAN	9.32	10.13	-0.81	68	0.0068
EMBEDDED	AL	36.11	33.61	2.50	18	0.5564
	DNR	52.31	50.51	1.08	36	0.7183
	WREC	71.92	71.92	0.00	13	1.0000
	MEAN	51.76	50.13	1.25	67	0.6195
CH_FLOW	AL	80.67	75.78	4.89	18	0.0968
	DNR	83.59	81.00	2.59	37	0.2044
	WREC	92.31	88.54	3.77	13	0.2736
	MEAN	84.49	81.06	3.43	68	0.0253
SHADING	AL	74.94	77.44	-2.50	18	0.2905
	DNR	63.92	68.70	-4.78	37	0.0048*
	WREC	68.62	62.31	6.31	13	0.0256
	MEAN	67.74	69.79	-2.06	68	0.8068
RIP_WID	AL	22.28	24.00	-1.72	18	0.5134
	DNR	23.73	22.46	1.27	37	0.4896
	WREC	26.31	26.54	-0.23	13	0.9406
	MEAN	23.84	23.65	0.19	68	0.8783
REMOTE	AL	6.78	6.22	0.56	18	0.3205
	DNR	9.00	8.43	0.57	37	0.1474
	WREC	10.00	10.31	-0.31	13	0.6391
	MEAN	8.60	8.21	0.40	68	0.3890
AESTHET	AL	13.22	13.50	-0.28	18	0.7620
	DNR	10.97	11.59	-0.62	37	0.3328
	WREC	13.54	13.38	0.15	13	0.8866
	MEAN	12.06	12.44	-0.38	68	0.6316

* significantly different at $p < 0.017$ (0.05/3)

Table 3.14. Frequency of occurrence of land use characteristics.

Land use Character	present	absent
OLD_FLD	181	884
DEC_FOR	900	165
CONI_FOR	91	974
WETLAND	164	901
SURFMINE	6	1059
LANDFILL	1	1064
RESIDENT	198	867
COMM_IND	68	997
CROPLAND	128	937
PASTURE	158	907
ORCH_VIN	4	1061

Table 3.15. Logistic regression results for each landuse-instream pair are summarized as positive (+), negative (-), or not significant (.) (p>0.05). Key metrics used for the MPHI are in bold.

INSTRM	OLD_FLD	DEC_FOR	CONI_FOR	WETLAND	RESIDENT	COMM_IND	CROPLAND	PASTURE
AESTHET	.	+	+	+	-	-	.	.
BANKSTAB	.	+	+	+	.	.	.	.
CHAN_ALT	.	+	+	.	.	-	.	.
CH_FLOW	.	-	.	.	.	.	.	+
EMBEDDED	.	.	-	+	-	.	.	.
EPI_SUB	.	+	+	-	.	-	-	-
INSTRHAB	.	+	+	.	.	-	-	-
MAXDEPTH	.	+	.	.	.	.	-	-
POOLQUAL	.	.	.	.	-	.	-	.
REMOTE	.	+	+	+	-	-	.	-
RIFFQUAL	.	+	.	-	.	.	-	.
RIP_WID	.	+	+	+	-	-	-	-
SHADING	.	+	+	.	.	-	.	-
VEL_DPTH	.	+	.	-	.	.	-	.

Tables 3.16 Order dependent regressions of quantity (volume) and quality (SMPHI) against three meansures of fish community richness: abundance per square meter (ASQ), number of species (NSPEC), and Fish index of biotic integrity (FISHIBI).

Dependent Variable: ASQ

order 1				order 2			
Variable	Parameter Estimate	F	Prob > |T|	Variable	Parameter Estimate	F	Prob > |T|
INTERCEP	1.157671		0.0856	INTERCEP	1.157671		0.0001
VOLUME	–0.00178	26.18	0.0001	SMPHI	0.004642	0.01	0.9097
SMPHI	0.00464	8.06	0.0046	VOLUME	–0.001784	67.90	0.0001

Dependent Variable: NSPEC

order 1				order 2			
Variable	Parameter Estimate	F	Prob > |T|	Variable	Parameter Estimate	F	Prob > |T|
INTERCEP	2.941953		0.0001	INTERCEP	2.941954		0.0001
VOLUME	0.018598	944.72	0.0001	SMPHI	0.080185	804.04	0.0001
SMPHI	0.080185	250.69	0.0001	VOLUME	0.018598	391.37	0.0001

Dependent Variable: FISHIBI

order 1				order 2			
Variable	Parameter Estimate	F	Prob > |T|	Variable	Parameter Estimate	F	Prob > |T|
INTERCEP	2.402324		0.0001	INTERCEP	2.402324		0.0001
VOLUME	0.000801	111.30	0.0001	SMPHI	0.016046	281.19	0.0001
SMPHI	0.016046	185.21	0.0001	VOLUME	0.000801	15.32	0.0001

Table 3.17. Pearson Correlation Coefficients for paired set of the following: ABUNDSQM = total abundance of fish/m^2; NSPEC = number of fish species; FISHIBI = Fish Index of Biotic Integrity; Volume = volume of area sampled and SMPHI = Scaled Maryland Physical Habitat Index.

	ABUNSQM	NSPEC	FISHIBI	VOLUME	SMPHI
ABUNSQM	1.00000 0.0 1065	0.37912 0.0001 1065	0.55724 0.0001 930	-0.00711 0.8168 1065	0.24652 0.0001 1065
NSPEC	0.37912 0.0001 1065	1.00000 0.0 1065	0.70237 0.0001 930	0.64691 0.0001 1065	0.59681 0.0001 1065
FISHIBI	0.55724 0.0001 930	0.70237 0.0001 930	1.00000 0.0 930	0.30161 0.0001 930	0.47940 0.0001 930
VOLUME	-0.00711 0.8168 1065	0.64691 0.0001 1065	0.30161 0.0001 930	1.00000 0.0 1169	0.46705 0.0001 1065
SMPHI	0.24652 0.0001 1065	0.59681 0.0001 1065	0.47940 0.0001 930	0.46705 0.0001 1065	1.00000 0.0 1065

Table 3.18. Summary of stepwise regression procedure for the dependent variable ABUNSQM (abundance per square meter).

Step	Variable Entered Removed Label	Number In	Model R**2	F	Prob>F
1	EMBEDDED	1	0.0596	58.8119	0.0001
2	VOLUME	2	0.0760	16.4756	0.0001
3	SHADING	3	0.0929	17.1939	0.0001
4	POOLQUAL	4	0.1066	14.1903	0.0002
5	MAXDEPTH	5	0.1211	15.2579	0.0001
6	BANKSTAB	6	0.1323	11.9250	0.0006
7	AESTHET	7	0.1419	10.3267	0.0014
8	INSTRHAB	8	0.1480	6.5685	0.0105
9	RIP_WID	9	0.1517	3.9858	0.0462
10	VEL_DPTH	10	0.1542	2.7807	0.0957
11	VEL_DPTH	9	0.1517	2.7807	0.0957

Table 3.19. Summary of stepwise regression procedure for the dependent variable NSPEC (number of fish species).

Step	Variable Entered Removed Label	Number In	Model R**2	F	Prob>F
1	VOLUME	1	0.3701	545.3482	0.0001
2	VEL_DPTH	2	0.4283	94.3230	0.0001
3	BANKSTAB	3	0.4457	29.0135	0.0001
4	SHADING	4	0.4566	18.6176	0.0001
5	MAXDEPTH	5	0.4654	15.2323	0.0001
6	AESTHET	6	0.4737	14.5780	0.0001
7	INSTRHAB	7	0.4752	2.6304	0.1052
8	INSTRHAB	6	0.4737	2.6304	0.1052

Table 3.20. Summary of stepwise procedure for dependent variable FISHIBI (fish Index of biotic Integrity).

Step	Variable Entered Removed Label	Number In	Model R**2	F	Prob>F
1	VEL_DPTH	1	0.1994	231.2005	0.0001
2	EMBEDDED	2	0.2380	46.8705	0.0001
3	AESTHET	3	0.2643	33.0959	0.0001
4	VOLUME	4	0.2857	27.7462	0.0001
5	CH_FLOW	5	0.2948	11.8609	0.0006
6	BANKSTAB	6	0.3037	11.8810	0.0006
7	INSTRHAB	7	0.3120	11.1384	0.0009
8	SHADING	8	0.3166	6.1184	0.0136

FIGURES

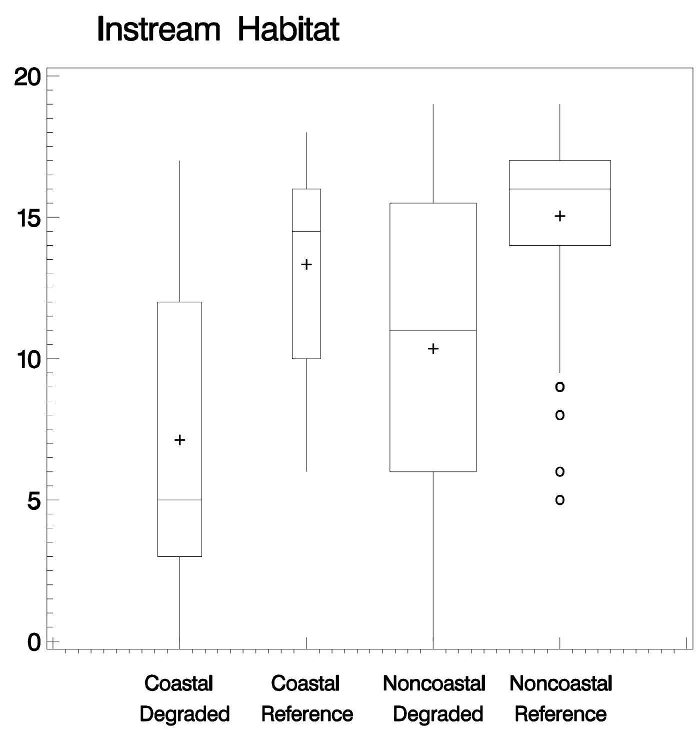
Figure 3.1 Box and Whisker plots of Number of Species (NSPEC) for streams with less the 300 acre watersheds in the coastal plain. Note that species richness ranged from 0 (7 sites) to 13 (1 site). Species richness was $\geq$ 5 for 7 streams (reference) and $\leq$ 1 for 11 sites (degraded).

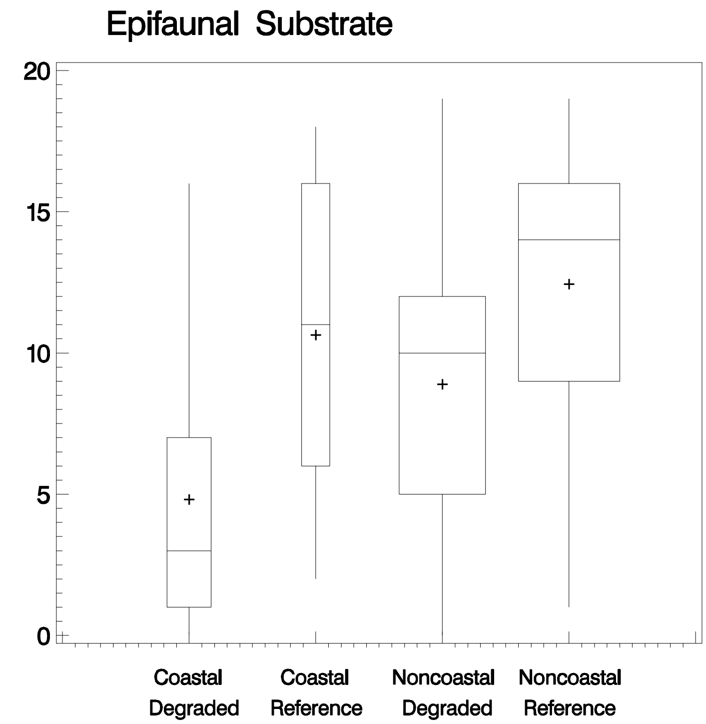
```
                 Variable=NSPEC        No. of  Species

                 Stem Leaf                           #  Boxplot
                   13 0                              1     0
                   12
                   11
                   10 0                              1     0
                    9
                    8
                    7 0                              1
                    6
                    5 0000                           4
                    4 00                             2
                    3 00000                          5
                    2 0000                           4      +
                    1 0000                           4
                    0 0000000                        7
```

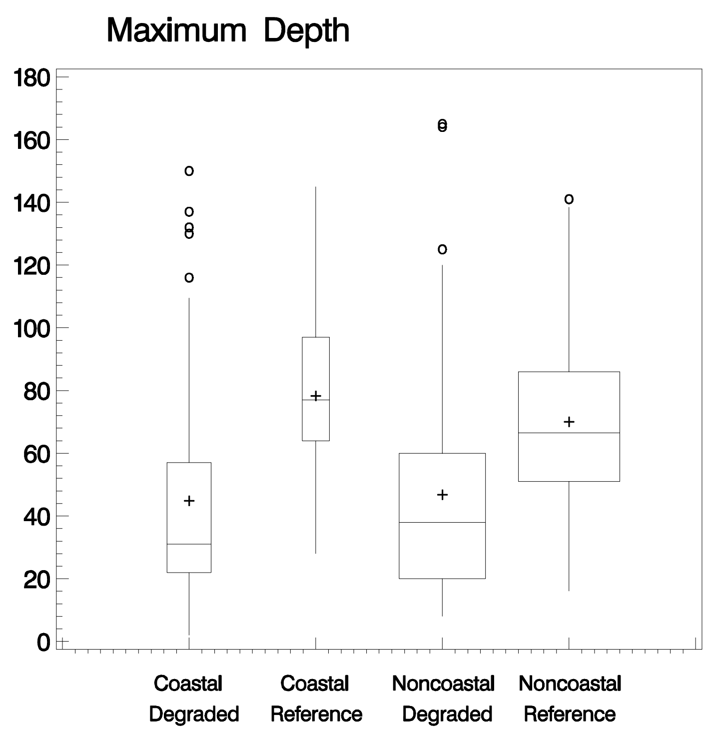
Figure 3.2 Box and Whisker plots of Number of Species (NSPEC) for streams with less the 300 acre watersheds in the non-coastal plain. Note that species richness ranged from 0 (32 sites) to 16 (1 site). Species richness was ≥ 5 for 8 sites (reference) and ≤ 1 for 38 sites (degraded).

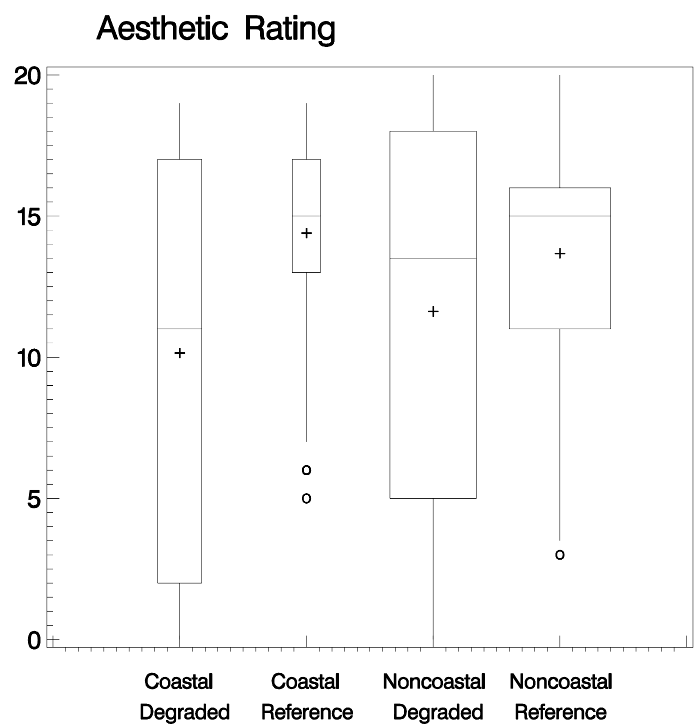
```
                 Variable=NSPEC         No. of  Species

       Stem Leaf                                          #  Boxplot
         16 0                                             1      *
         15
         14
         13
         12 0                                             1      0
         11
         10
          9
          8
          7 0                                             1      |
          6 00                                            2      |
          5 000                                           3      |
          4                                                      |
          3 0000000000                                   10   +-----+
          2 0000000000000                                13   |     |
          1 000000                                        6   *--+--*
          0 00000000000000000000000000000000             32   +-----+
            ----+----+----+----+----+----+----+
```

Figure 3.3 Box and Whisker plots for degraded and reference Coastal and Non-Coastal Plain stream sites by continuous metric. The x-axis defines four groups as labeled. The Y-axis is defined in units of the metric presented. The width of each box is proportional to sample size. For each group, the lower end of the box shows the 25th centile of the observations in that group. The upper end of the box shows the 75th centile. It follows that the box covers the range of the middle 50 percent of the observations. This range is called the inter-quartile range. The bar across the box shows the 50th centile which is also called the median. The plus (+) shows the location of the mean for the group. The whiskers, verticle lines above and below the box, extend to either the most extreme datum beyond the box or 1.5 times the inter-quartile range beyond the box whichever is nearer the box. Data that fall beyond the whiskers and within three times the inter-quartile range are marked by 0 to indicate outliers. Data more than three time the inter-quartile range from the box are marked by * to indicate extreme outliers.

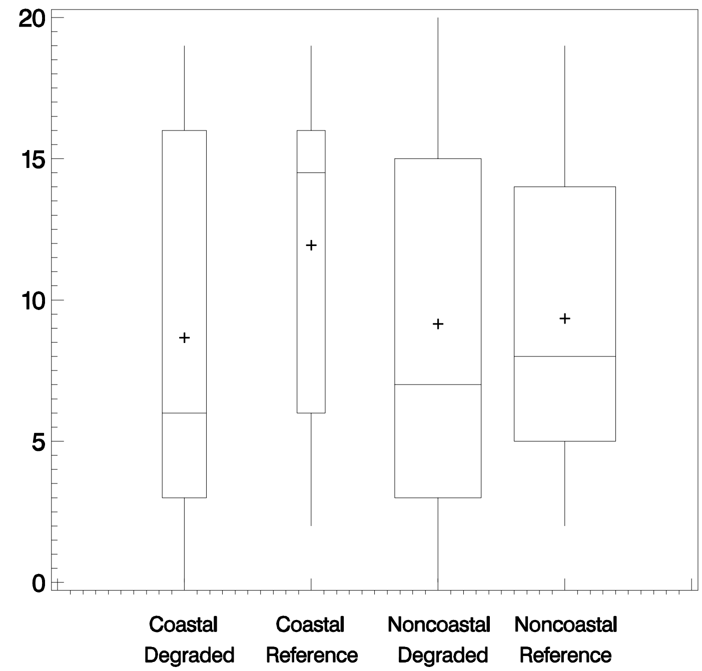



Epifaunal Substrate
20
15
10
5
0
Coastal Degraded
Coastal Reference
Noncoastal Degraded
Noncoastal Reference

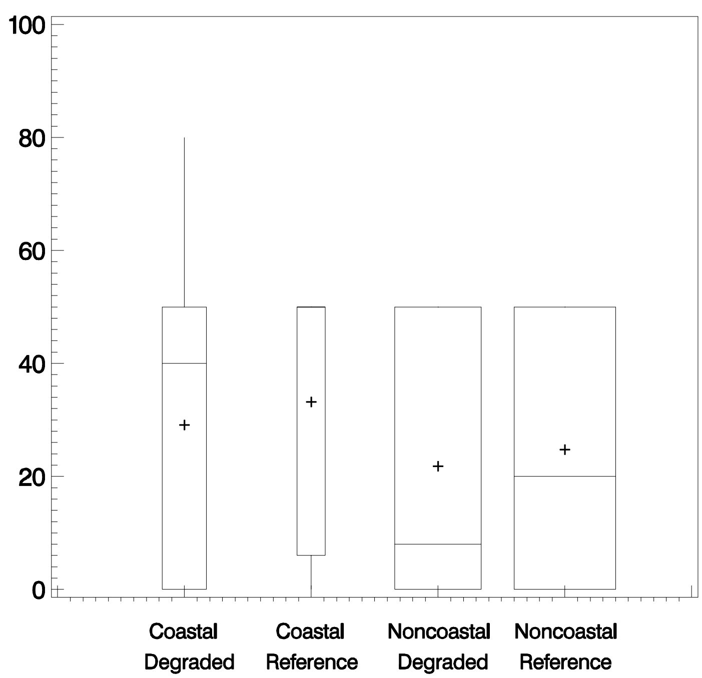

Maximum Depth
180
160
140
120
100
80
60
40
20
0
Coastal Degraded
Coastal Reference
Noncoastal Degraded
Noncoastal Reference

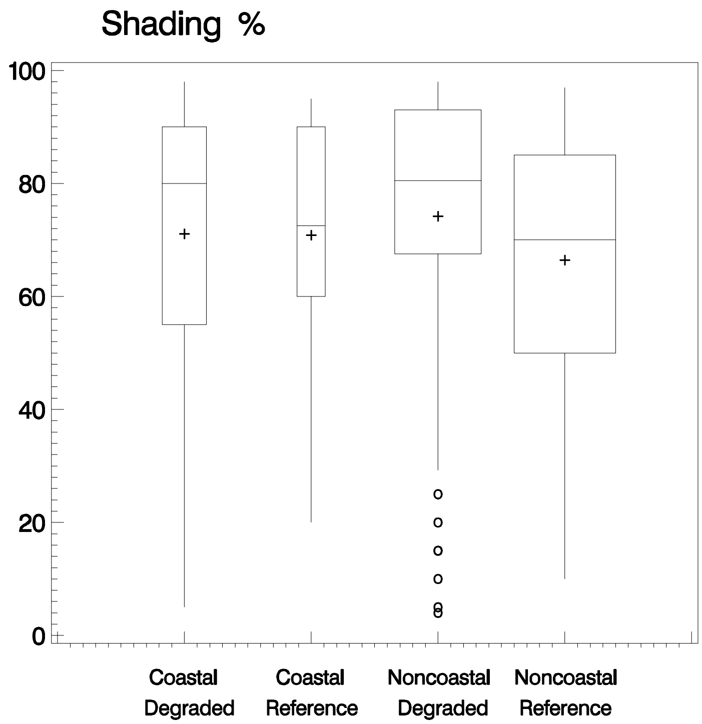

Aesthetic Rating
20
15
10
5
0
Coastal Degraded
Coastal Reference
Noncoastal Degraded
Noncoastal Reference

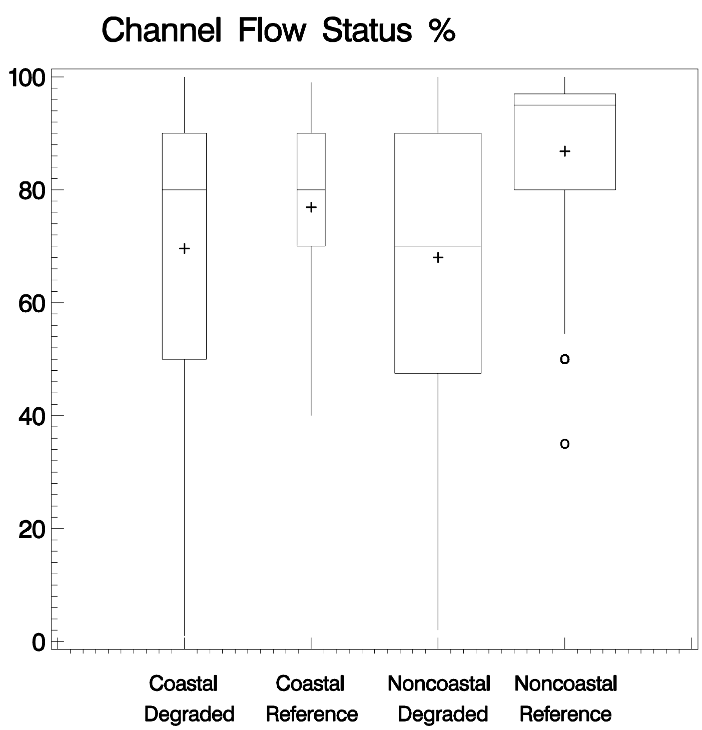
Remoteness Rating

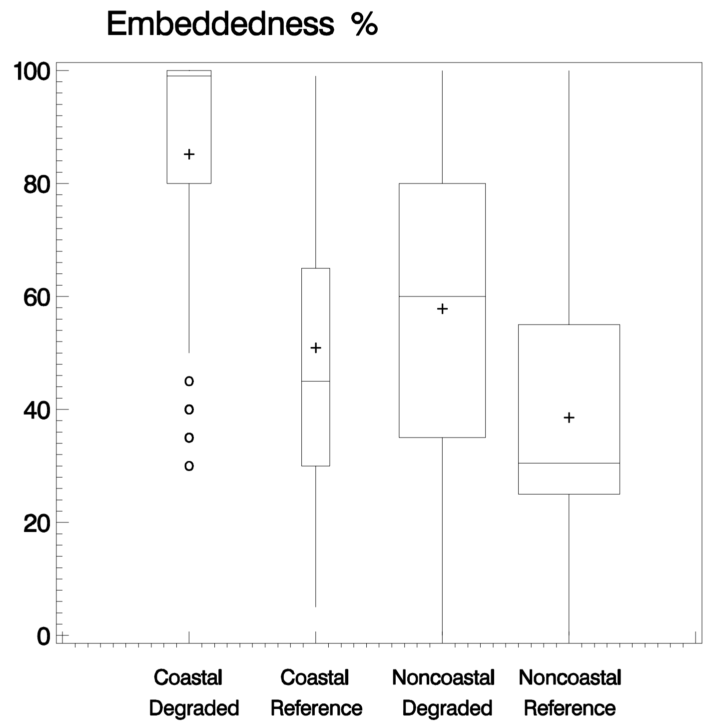


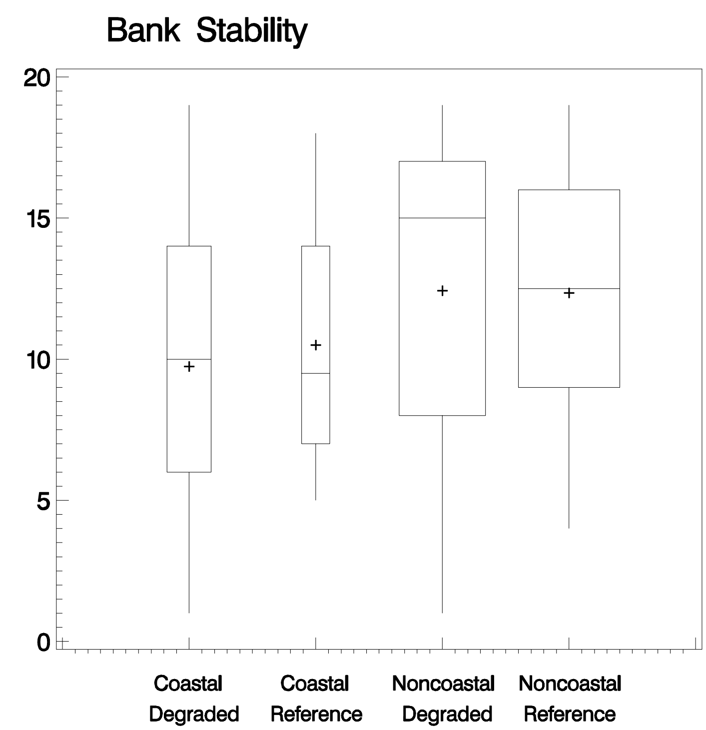
Riparian Buffer Width

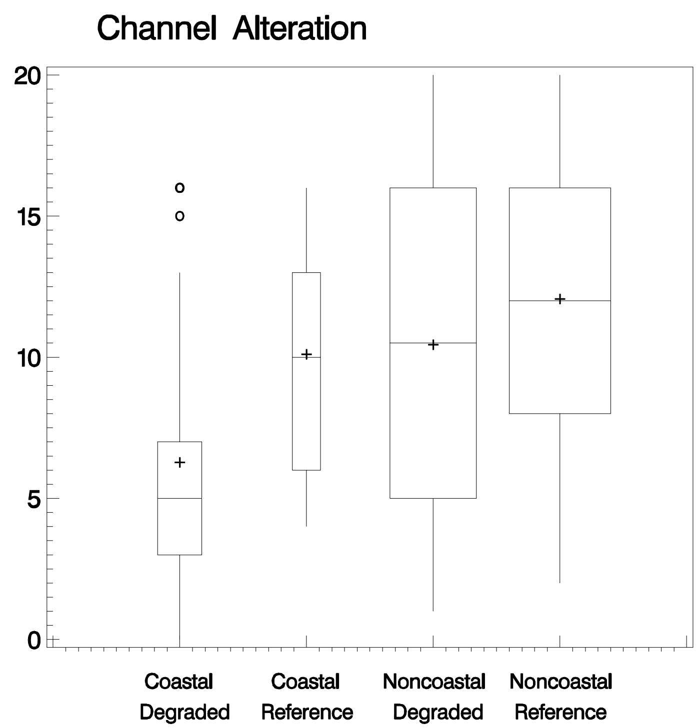


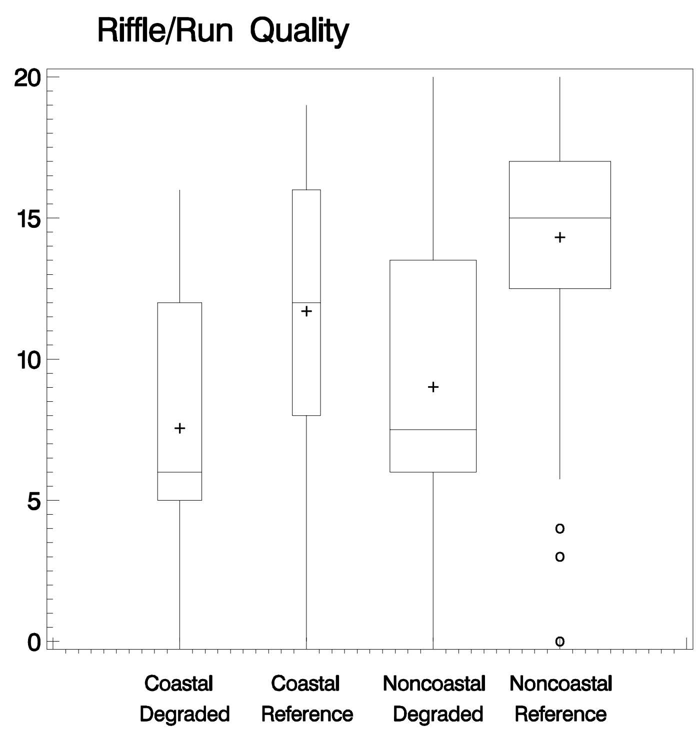

Shading %
100
80
60
40
20
0
Coastal Degraded
Coastal Reference
Noncoastal Degraded
Noncoastal Reference


Channel Flow Status %
100
80
60
40
20
0
Coastal Degraded
Coastal Reference
Noncoastal Degraded
Noncoastal Reference


Embeddedness %
100
80
60
40
20
0
Coastal Degraded
Coastal Reference
Noncoastal Degraded
Noncoastal Reference


Bank Stability
20
15
10
5
0
Coastal Degraded
Coastal Reference
Noncoastal Degraded
Noncoastal Reference


Channel Alteration
20
15
10
5
0
Coastal Degraded
Coastal Reference
Noncoastal Degraded
Noncoastal Reference


Riffle/Run Quality
20
15
10
5
0
Coastal Degraded
Coastal Reference
Noncoastal Degraded
Noncoastal Reference

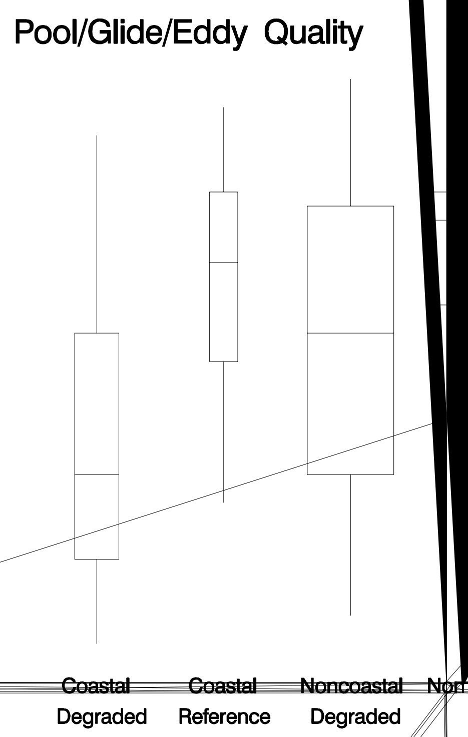

Pool/Glide/Eddy Quality
Coastal
Degraded
Coastal
Reference
Noncoastal
Degraded
Non

Figure 3.4 Parallel axis plots for sites with good Fish IBI scores (Fish IBI>4.0) and MPHI scores separated by category.

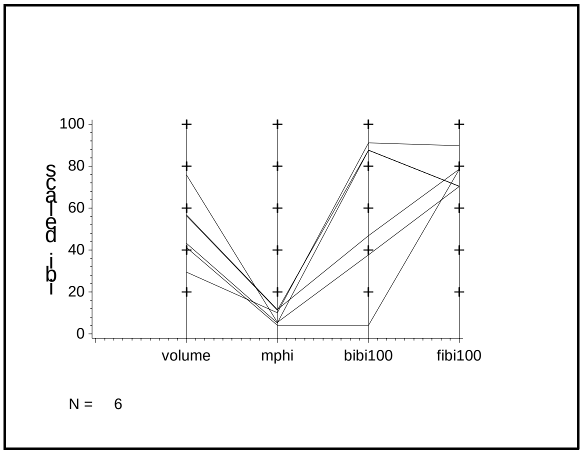


Figure A. Good FIBI and Very Poor MPHI.

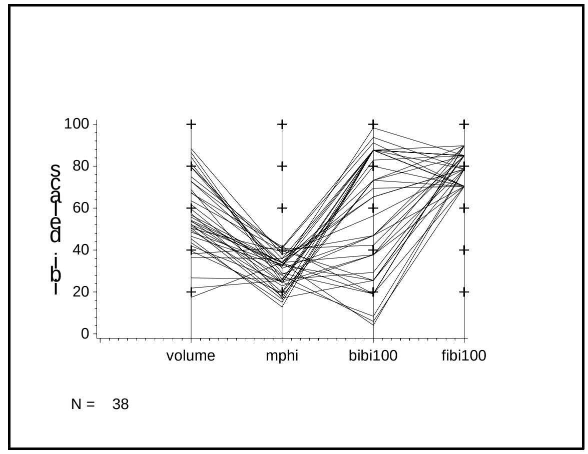


Figure B. Good FIBI and Poor MPHI.

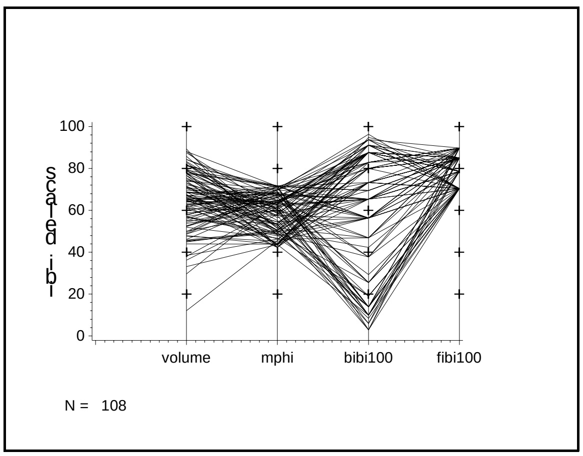


Figure C. Good FIBI and Fair MPHI.

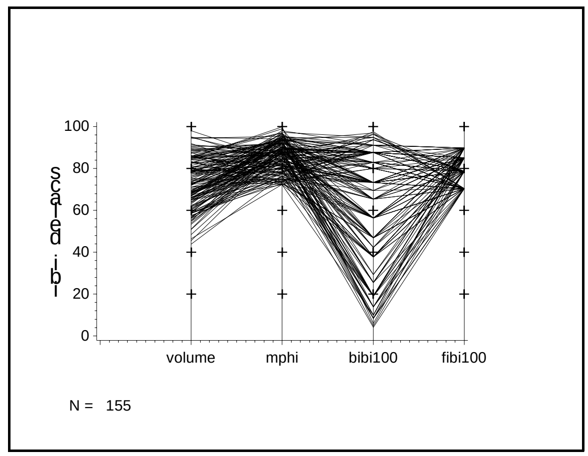


Figure D. Good FIBI and Good MPHI.

Figure 3.5 Parallel axis plots for sites with very poor Fish IBI scores (Fish IBI<2.0) and MPHI scores separated by category.

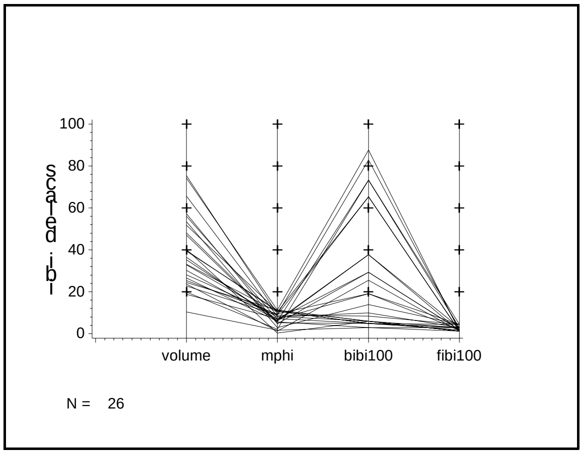


Figure A - Very Poor FIBI and Very Poor MPHI.

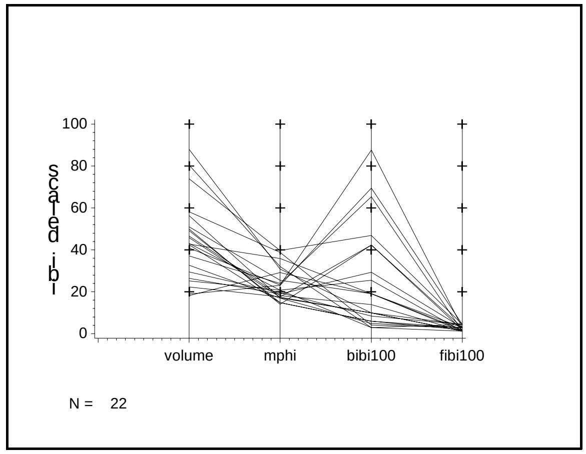


Figure B. Very Poor FIBI and Poor MPHI.

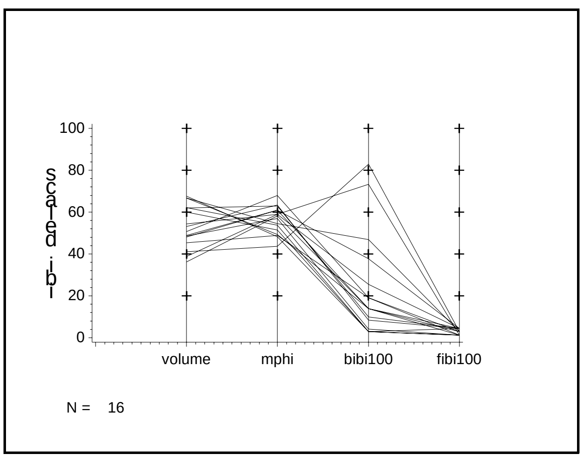


Figure C. Very Poor FIBI and Fair MPHI.

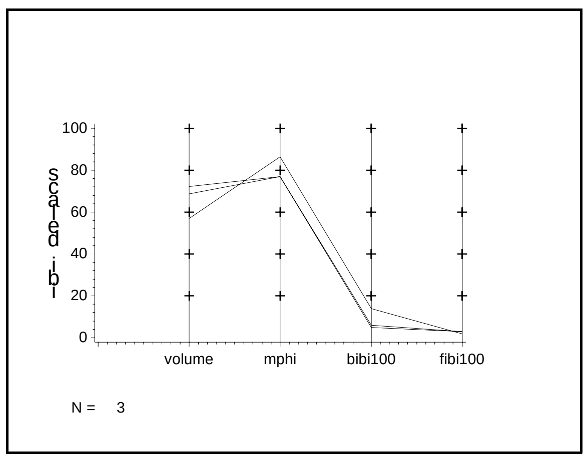
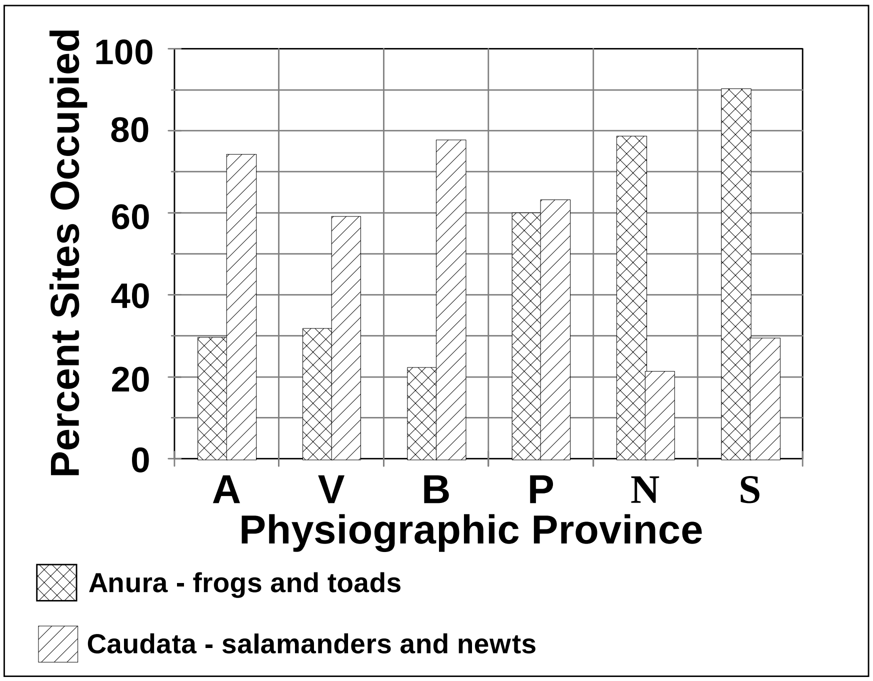


Figure D. Very Poor FIBI and Good MPHI.

Figure 3.6 Percent of occupied stream miles by physiographic province: A=Allegheny Plateau, V=Great Valley, B=Blue Ridge, P=Piedmont, N=Northern Coastal Plain and S=Southern Coastal Plain.



APPENDIX A

Classification of Coastal and Non-Coastal Plain Streams as Degraded (D), Reference (R) and Unclassified (U) for (1994-96).

Classification of Coastal Plain streams as degraded, reference, and unclassified

Sampling Year=94

OBS	REGION	BASIN	COASTAL	SITE	ORDER	PH_FLD	ANC	NO3	DO	DOC	FOREST	URBAN	FISHIBI	CLASS
1	C	PX	1	AA-N-176-1	1	6.40	763.04	1.152	7.2	8	30.24	52.08	2.50	U
2	C	PX	1	AA-N-268-2	1	7.30	668.68	0.570	9.3	6	37.12	53.88	.	
3	C	PX	1	AA-N-268-4	1	8.33	668.68	0.570	7.0	6	42.99	57.42	.	
4	C	PX	1	CA-S-001-1	1	6.42	176.60	1.002	7.8	6	73.63	8.76	.	
5	C	PX	1	CA-S-001-2	1	6.07	176.60	1.002	5.8	6	57.45	3.28	.	
6	C	PX	1	CA-S-108-3	2	6.31	363.64	0.304	7.6	3	71.70	13.71	1.75	D
7	C	PX	1	CA-S-108-7	2	6.34	363.64	0.304	6.4	3	71.59	13.77	1.50	D
8	C	PX	1	CA-S-156-1	2	6.31	335.27	0.290	7.9	3	69.43	17.16	1.25	D
9	C	PX	1	CA-S-156-2	2	6.30	335.27	0.290	8.7	3	70.76	16.18	2.25	U
10	C	PX	1	CA-S-209-1	1	6.02	106.09	0.170	7.3	2	89.33	1.32	.	
11	C	PX	1	CA-S-209-2	1	6.18	106.09	0.170	8.4	2	81.04	0.58	.	
12	C	PX	1	PG-N-003-2	2	6.28	346.99	0.664	6.3	4	41.06	42.06	2.75	U
13	C	PX	1	PG-N-003-3	2	6.27	346.99	0.664	8.1	4	41.14	42.06	3.00	U
14	C	PX	1	PG-N-087-2	1	6.30	93.63	0.979	1.9	2	35.66	10.40	.	
15	C	PX	1	PG-N-141-1	2	6.32	248.67	0.852	5.6	2	41.01	42.15	4.25	U
16	C	PX	1	PG-N-141-2	2	6.45	248.67	0.852	8.6	2	28.29	25.41	4.25	U
17	C	PX	1	PG-N-194-1	2	6.90	292.11	0.734	8.0	3	38.59	25.11	3.75	U
18	C	PX	1	PG-N-194-2	2	6.97	292.11	0.734	6.8	3	38.03	26.30	4.00	U
19	C	PX	1	PG-N-205-2	1	6.34	337.14	1.186	9.2	2	26.38	8.96	.	
20	C	PX	1	PG-N-205-4	1	6.51	337.14	1.186	8.5	2	30.08	26.90	3.50	U
21	C	PX	1	PG-N-206-1	1	6.24	158.89	0.811	6.1	2	28.79	12.97	2.75	U
22	C	PX	1	PG-N-206-2	1	6.42	158.89	0.811	8.6	2	26.13	11.91	2.25	U
23	C	PX	1	PG-N-219-5	3	6.59	320.44	0.693	4.9	3	37.90	38.17	3.75	U
24	C	PX	1	PG-N-259-1	2	6.94	336.29	0.757	8.8	3	40.65	18.18	4.25	R
25	C	PX	1	PG-N-259-2	2	7.13	336.29	0.757	8.3	3	41.39	17.94	4.00	R
26	C	PX	1	PG-N-271-9	1	6.43	230.08	4.332	2.4	5	50.10	1.84	.	
27	C	PX	1	SM-S-214-1	1	5.80	1490.73	0.087	7.6	2	63.10	30.05	.	
28	C	PX	1	SM-S-214-2	1	6.38	1490.73	0.087	8.0	2	76.49	15.70	2.00	D
29	C	WC	1	AA-N-011-3	1	6.79	714.59	0.679	6.4	2	34.92	51.53	2.25	U
30	C	WC	1	AA-N-017-2	1	5.97	630.82	0.882	6.8	3	34.59	19.83	.	
31	C	WC	1	AA-N-017-4	1	6.12	630.82	0.882	7.4	3	18.79	25.63	.	
32	C	WC	1	AA-N-022-1	2	6.97	388.77	0.983	6.5	5	46.24	46.30	2.00	D
33	C	WC	1	AA-N-022-2	2	7.08	388.77	0.983	7.3	5	45.49	47.23	2.00	D
34	C	WC	1	AA-N-082-1	1	6.70	34.24	0.210	6.8	3	72.69	18.34	1.00	D
35	C	WC	1	AA-N-082-2	1	6.84	34.24	0.210	7.9	3	67.62	32.69	1.00	D
36	C	WC	1	AA-N-102-1	1	6.64	122.93	2.068	8.1	1	13.62	4.50	1.75	D
37	C	WC	1	AA-N-102-2	1	6.96	122.93	2.068	8.1	1	36.16	13.45	1.75	D

Classification of Coastal Plain streams as degraded, reference, and unclassified.

Sampling Year=94
(continued)

OBS	REGION	BASIN	COASTAL	SITE	ORDER	PH_FLD	ANC	NO3	DO	DOC	FOREST	URBAN	FISHIBI	CLASS
38	C	WC	1	AA-N-106-2	2	6.96	189.98	0.301	7.7	2	49.81	16.21	2.00	D
39	C	WC	1	AA-N-164-1	2	3.80	-15.82	0.097	1.2	8	37.96	55.84	1.00	U
40	C	WC	1	AA-N-164-2	2	4.45	-15.82	0.097	2.7	8	36.18	57.68	1.00	U
41	C	WC	1	AA-N-178-1	3	7.05	208.33	0.455	8.0	8	54.26	34.71	2.50	U
42	C	WC	1	AA-N-178-2	3	7.15	208.33	0.455	7.9	8	54.26	34.72	2.50	U
43	C	WC	1	AA-N-281-1	3	7.07	205.11	0.493	8.0	7	54.34	35.24	2.50	U
44	C	WC	1	AA-N-281-2	3	7.04	205.11	0.493	8.1	7	54.39	35.19	2.25	U
45	C	WC	1	AA-N-288-3	2	6.03	-19.40	0.161	4.9	4	62.32	21.42	1.50	U
46	C	WC	1	CA-S-019-1	1	5.80	203.08	0.179	2.0	3	65.76	20.61	.	
47	C	WC	1	CA-S-041-1	1	6.73	307.68	0.578	7.8	2	61.03	10.72	1.00	D
48	C	WC	1	CA-S-041-2	1	6.00	307.68	0.578	5.8	2	63.70	9.92	1.25	D
49	C	WC	1	CA-S-088-1	2	5.95	231.88	0.112	8.2	3	85.05	2.68	1.00	D
50	C	WC	1	CA-S-088-2	2	6.42	231.88	0.112	6.5	3	84.21	2.83	1.00	D
51	C	WC	1	CA-S-207-1	1	6.82	229.74	0.070	8.9	6	41.68	46.55	2.75	U
52	E	CK	1	CN-N-002-1	3	6.74	211.65	0.886	5.1	12	46.22	6.02	3.50	U
53	E	CK	1	CN-N-002-2	3	7.12	211.65	0.886	6.9	12	46.36	6.05	3.25	U
54	E	CK	1	CN-N-023-3	1	6.80	267.24	1.989	3.5	9	34.76	0.00	.	
55	E	CK	1	CN-N-028-1	1	6.35	175.69	9.228	8.5	6	9.05	7.01	2.25	U
56	E	CK	1	CN-N-028-2	1	6.27	175.69	9.228	6.8	6	3.97	0.88	2.75	U
57	E	CK	1	CN-N-034-1	1	7.15	323.42	7.859	7.2	6	18.49	4.04	3.00	U
58	E	CK	1	CN-N-034-2	1	7.00	323.42	7.859	6.7	6	20.69	0.00	2.75	U
59	E	CK	1	CN-N-035-1	1	6.72	153.98	3.300	5.8	8	18.23	0.36	2.50	U
60	E	CK	1	CN-N-035-2	1	6.69	153.98	3.300	6.1	8	21.76	2.64	3.25	U
61	E	CK	1	CN-N-039-2	1	6.89	216.96	2.309	6.5	12	34.64	0.00	3.25	U
62	E	CK	1	CN-N-044-1	2	6.85	164.43	1.901	5.8	8	43.25	3.19	4.00	R
63	E	CK	1	CN-N-044-3	2	6.85	164.43	1.901	8.5	8	50.04	0.97	4.50	R
64	E	CK	1	QA-N-040-1	2	7.08	427.99	7.529	8.5	5	29.30	0.19	2.50	U
65	E	CK	1	QA-N-040-2	2	6.90	427.99	7.529	8.2	5	28.99	0.19	4.00	U
66	E	CK	1	QA-N-105-1	2	6.74	213.98	1.500	6.8	7	36.14	0.29	4.00	R
67	E	CK	1	QA-N-105-2	2	6.74	213.98	1.500	4.2	7	30.88	0.00	4.00	R
68	E	CK	1	QA-N-114-2	1	7.93	198.65	6.910	11.5	4	30.08	1.19	2.75	U
69	E	CK	1	TA-N-015-1	1	6.99	611.19	7.283	6.4	8	14.13	7.20	2.75	U
70	E	CK	1	TA-N-015-5	1	7.34	611.19	7.283	6.5	8	9.88	8.09	2.75	U
71	E	CK	1	TA-N-048-3	1	6.69	229.23	2.975	5.8	12	29.43	0.00	3.00	U
72	E	CK	1	TA-N-048-4	1	6.78	229.23	2.975	5.8	12	27.95	0.00	2.25	U
73	E	CK	1	TA-N-062-1	2	6.57	391.30	5.332	7.6	7	30.00	10.00	4.75	U

Classification of Coastal Plain streams as degraded, reference, and unclassified.

Sampling Year=94
(continued)

OBS	REGION	BASIN	COASTAL	SITE	ORDER	PH_FLD	ANC	NO3	DO	DOC	FOREST	URBAN	FISHIBI	CLASS
74	E	PC	1	WO-S-008-1	3	6.54	110.20	1.826	5.6	13	75.00	0.00	3.25	U
75	E	PC	1	WO-S-008-3	3	6.58	110.20	1.826	5.8	13	75.00	0.00	3.00	U
149	W	PW	1	PG-N-015-1	3	6.88	460.30	0.451	5.3	4	47.56	38.56	3.50	U
150	W	PW	1	PG-N-063-2	1	6.45	650.16	2.084	7.6	3	25.49	73.96	1.00	D
151	W	PW	1	PG-N-063-6	1	7.07	650.16	2.084	8.2	3	20.00	80.00	1.50	D
152	W	PW	1	PG-N-069-2	1	6.36	111.99	1.153	9.4	2	46.27	15.49	.	
153	W	PW	1	PG-N-081-1	2	7.27	551.52	0.632	9.5	4	32.33	53.39	1.75	D
154	W	PW	1	PG-N-081-2	2	7.77	551.52	0.632	10.0	4	31.35	54.57	1.00	D
155	W	PW	1	PG-N-119-1	1	7.10	627.17	1.413	6.4	2	21.07	77.78	1.00	D
156	W	PW	1	PG-N-119-2	1	6.85	627.17	1.413	6.7	2	13.97	82.24	.	
157	W	PW	1	PG-N-137-1	3	7.37	624.25	0.753	9.0	3	40.86	45.52	3.50	U
158	W	PW	1	PG-N-137-2	3	6.81	624.25	0.753	9.4	3	40.22	46.35	4.50	U
159	W	PW	1	PG-N-239-2	1	7.55	805.72	1.700	9.3	3	32.89	32.92	.	
160	W	PW	1	PG-N-239-3	1	7.68	805.72	1.700	9.5	3	33.39	32.55	.	
161	W	PW	1	PG-N-260-1	2	8.14	980.58	1.670	12.8	7	35.77	50.95	1.00	D
162	W	PW	1	PG-N-260-2	2	7.45	980.58	1.670	8.4	7	33.37	53.66	3.75	U

Sampling Year=95

OBS	REGION	BASIN	COASTAL	SITE	ORDER	PH_FLD	ANC	NO3	DO	DOC	FOREST	URBAN	FISHIBI	CLASS
185	C	LP	1	CH-S-012-114	1	6.61	77.03	0.340	8.4	3	96.10	0.00	3.50	U
186	C	LP	1	CH-S-016-225	2	6.36	98.23	0.299	7.7	6	56.07	26.34	3.00	U
187	C	LP	1	CH-S-033-314	3	6.52	107.92	0.239	7.1	4	63.83	18.06	3.50	U
188	C	LP	1	CH-S-039-203	2	6.16	165.55	0.197	7.9	3	48.87	24.87	.	
189	C	LP	1	CH-S-039-224	2	6.29	109.99	0.451	7.9	5	81.47	13.00	2.50	U
190	C	LP	1	CH-S-062-313	3	6.59	82.72	0.512	2.5	5	62.10	13.36	4.50	U
191	C	LP	1	CH-S-080-222	2	5.75	39.95	0.130	1.8	4	63.94	17.77	1.25	U
192	C	LP	1	CH-S-086-217	2	6.23	93.26	0.993	5.6	5	68.37	8.18	3.50	U

Classification of Coastal Plain streams as degraded, reference, and unclassified.

Sampling Year=95
(continued)

OBS	REGION	BASIN	COASTAL	SITE	ORDER	PH_FLD	ANC	NO3	DO	DOC	FOREST	URBAN	FISHIBI	CLASS
193	C	LP	1	CH-S-089-205	2	6.50	75.26	0.221	7.9	4	87.08	7.39	4.75	R
194	C	LP	1	CH-S-100-108	1	6.95	132.01	0.387	7.8	3	99.32	0.00	.	
195	C	LP	1	CH-S-105-119	1	6.21	107.50	0.284	7.9	7	91.45	7.83	2.75	U
196	C	LP	1	CH-S-139-116	1	5.67	17.08	0.474	2.5	5	66.43	6.98	2.25	U
197	C	LP	1	CH-S-177-129	1	5.97	19.12	0.136	1.2	8	72.95	8.81	2.75	U
198	C	LP	1	CH-S-188-134	1	6.34	76.66	0.682	7.1	6	62.73	7.17	.	
199	C	LP	1	CH-S-213-120	1	5.80	-11.44	0.131	0.3	4	66.54	7.01	2.00	U
200	C	LP	1	CH-S-217-201	2	6.78	322.35	0.270	7.4	6	85.98	6.31	5.00	R
201	C	LP	1	CH-S-225-324	3	5.91	37.27	0.274	6.2	2	73.53	7.43	3.50	U
202	C	LP	1	CH-S-234-315	3	5.67	28.31	0.538	9.0	4	78.56	6.32	3.75	U
203	C	LP	1	CH-S-257-306	3	5.65	33.18	0.599	8.3	4	82.21	5.38	4.25	U
204	C	LP	1	CH-S-271-219	2	6.87	165.99	0.452	6.2	6	61.73	18.85	4.00	R
205	C	LP	1	CH-S-288-101	1	6.27	91.11	0.758	7.9	3	40.23	0.66	4.50	R
206	C	LP	1	CH-S-292-211	2	6.58	108.69	0.557	3.1	3	51.37	32.14	4.50	U
207	C	LP	1	CH-S-293-136	1	4.86	17.36	0.598	6.9	2	66.81	12.13	.	
208	C	LP	1	CH-S-299-202	2	5.29	17.19	1.215	7.1	5	77.54	5.09	4.25	U
209	C	LP	1	CH-S-327-221	2	5.83	49.17	0.441	6.1	5	51.03	31.87	4.00	U
210	C	LP	1	CH-S-331-301	3	7.18	86.27	0.333	1.2	3	77.61	6.74	3.75	U
211	C	LP	1	CH-S-331-304	3	6.86	81.48	0.329	6.4	3	78.17	6.48	4.50	R
212	C	LP	1	PG-S-032-209	2	5.90	130.69	0.396	3.2	5	63.49	17.13	2.25	U
213	C	LP	1	PG-S-052-109	1	5.96	58.82	0.705	6.0	5	77.09	11.13	4.00	U
214	C	LP	1	SM-S-006-212	2	6.42	364.41	0.451	6.5	8	66.44	6.09	4.00	R
215	C	LP	1	SM-S-007-138	1	5.27	50.89	0.257	2.2	7	53.21	42.25	1.25	D
216	C	LP	1	SM-S-036-107	1	7.31	611.43	0.423	7.4	4	61.98	0.84	2.50	U
217	C	LP	1	SM-S-039-127	1	7.24	596.28	1.375	7.3	3	36.44	0.00	3.75	U
218	C	LP	1	SM-S-040-128	1	6.55	113.56	0.223	6.5	6	68.27	6.84	3.50	U
219	C	LP	1	SM-S-051-132	1	6.29	313.88	0.200	7.5	4	82.36	0.00	.	
220	C	LP	1	SM-S-104-126	1	6.05	69.82	0.293	5.0	6	64.33	37.68	.	
221	C	LP	1	SM-S-111-112	1	6.53	182.65	0.353	6.9	7	63.38	22.94	4.75	U
222	C	LP	1	SM-S-199-302	3	6.90	452.86	0.460	4.7	6	56.76	9.34	4.50	R
223	C	LP	1	SM-S-209-105	1	6.57	107.35	0.194	3.5	6	54.96	7.86	1.25	D
224	C	LP	1	SM-S-237-103	1	6.85	499.16	1.383	6.3	6	39.32	8.95	4.00	R
225	C	LP	1	SM-S-239-310	3	6.87	457.95	0.492	7.3	6	56.11	8.85	4.00	R
226	C	PP	1	AA-N-030-223	2	7.50	385.44	1.297	7.7	3	63.17	34.40	4.25	U
227	C	PP	1	AA-N-104-114	1	6.78	1038.95	0.927	5.4	5	5.01	79.38	1.75	D
228	C	PP	1	AA-N-126-306	3	7.02	714.82	1.396	8.4	6	31.43	58.41	3.50	U

Classification of Coastal Plain streams as degraded, reference, and unclassified.

Sampling Year=95
(continued)

OBS	REGION	BASIN	COASTAL	SITE	ORDER	PH_FLD	ANC	NO3	DO	DOC	FOREST	URBAN	FISHIBI	CLASS
229	C	PP	1	AA-N-172-209	2	6.94	295.51	1.849	8.2	4	50.74	30.02	3.00	U
230	C	PP	1	AA-N-180-130	1	6.30	216.63	3.619	7.6	5	38.48	58.35	3.00	U
231	C	PP	1	AA-N-244-203	2	7.33	946.94	3.112	7.9	2	13.61	84.76	2.25	U
232	C	PP	1	BA-N-019-301	3	7.78	1331.36	1.727	8.3	2	22.55	77.39	2.00	D
233	C	PP	1	BA-N-019-308	3	8.20	1876.29	0.784	9.3	2	21.03	78.93	1.75	D
249	C	PP	1	BC-N-014-216	2	7.27	2030.42	1.212	4.4	4	4.52	95.47	2.25	U
250	C	PP	1	BC-N-014-224	2	7.92	1973.15	1.073	9.0	4	4.52	95.47	2.75	U
251	C	PP	1	BC-N-015-219	2	7.78	1198.85	1.515	7.6	5	6.91	92.25	3.00	U
277	C	PP	1	HO-N-001-210	2	6.66	1224.88	0.549	7.5	3	56.96	20.27	4.00	U
278	C	PP	1	HO-N-018-213	2	7.53	1478.26	1.015	8.3	3	54.45	35.17	4.00	U
283	E	CR	1	KE-N-018-216	2	6.90	678.75	1.545	5.6	3	13.42	6.44	3.00	U
284	E	CR	1	KE-N-045-108	1	4.52	7.58	0.185	3.2	21	71.30	4.55	1.25	D
285	E	CR	1	KE-N-046-226	2	7.03	348.20	2.344	4.5	6	36.61	0.00	4.50	R
286	E	CR	1	KE-N-067-213	2	6.72	350.97	6.269	8.0	5	27.42	0.00	2.50	U
287	E	CR	1	KE-N-096-102	1	6.26	100.36	0.116	0.8	20	67.69	0.00	2.75	U
288	E	CR	1	KE-N-128-122	1	6.86	696.52	1.876	6.3	4	13.10	1.41	4.25	U
289	E	CR	1	QA-N-007-217	2	6.71	304.55	6.248	6.7	5	33.64	1.47	3.25	U
290	E	CR	1	QA-N-010-107	1	6.85	362.64	14.257	8.6	3	36.12	0.00	.	
291	E	CR	1	QA-N-014-204	2	7.20	766.63	2.812	6.2	9	34.67	1.47	4.75	R
292	E	CR	1	QA-N-014-219	2	7.22	674.63	4.704	4.9	7	36.15	0.00	4.25	U
293	E	CR	1	QA-N-024-209	2	7.86	801.98	1.109	6.4	7	62.69	0.00	4.00	R
294	E	CR	1	QA-N-030-128	1	7.62	1091.90	0.977	6.1	7	49.11	1.93	2.75	U
295	E	CR	1	QA-N-031-202	2	6.94	1314.69	1.757	1.2	9	29.94	3.80	2.00	U
296	E	CR	1	QA-N-031-203	2	6.98	1077.91	1.634	2.7	8	30.10	3.84	4.00	U
297	E	CR	1	QA-N-031-225	2	7.17	1352.84	1.440	4.2	9	30.14	3.87	3.75	U
298	E	CR	1	QA-N-033-301	3	7.07	339.82	5.353	6.5	2	28.52	2.60	4.50	U
299	E	CR	1	QA-N-033-304	3	6.79	362.65	5.198	7.6	4	25.50	2.43	3.00	U
300	E	CR	1	QA-N-033-309	3	7.20	346.94	5.165	6.2	3	28.66	2.46	4.50	U
301	E	CR	1	QA-N-033-310	3	7.23	363.11	5.244	7.4	3	28.72	2.43	4.25	U
302	E	CR	1	QA-N-033-311	3	7.17	398.72	5.449	7.1	2	25.55	2.36	4.75	U
303	E	CR	1	QA-N-033-313	3	6.90	388.17	5.452	6.3	2	25.63	2.59	4.75	U
304	E	CR	1	QA-N-033-314	3	7.26	329.10	5.257	6.7	3	28.33	2.15	4.50	U
305	E	CR	1	QA-N-033-317	3	6.78	361.68	5.282	6.7	4	25.49	2.42	4.00	U
306	E	CR	1	QA-N-033-318	3	6.99	389.10	5.265	6.4	3	25.54	2.40	3.00	U
307	E	CR	1	QA-N-033-321	3	7.23	340.08	5.121	7.5	3	28.75	2.42	4.25	U
308	E	CR	1	QA-N-041-109	1	7.16	430.35	1.118	1.5	11	54.96	0.50	3.25	U

Classification of Coastal Plain streams as degraded, reference, and unclassified.

Sampling Year=95
(continued)

OBS	REGION	BASIN	COASTAL	SITE	ORDER	PH_FLD	ANC	NO3	DO	DOC	FOREST	URBAN	FISHIBI	CLASS
309	E	CR	1	QA-N-041-113	1	7.14	203.38	0.256	4.4	16	57.91	0.00	2.50	U
310	E	CR	1	QA-N-042-116	1	7.44	1020.49	3.283	6.9	4	11.94	17.98	3.50	U
311	E	CR	1	QA-N-048-221	2	7.70	912.69	4.639	6.3	5	29.70	0.93	3.75	U
312	E	CR	1	QA-N-059-125	1	6.54	243.10	1.650	2.1	16	53.81	3.72	3.50	U
313	E	CR	1	QA-N-066-207	2	7.32	1249.76	1.541	5.0	9	29.53	2.85	3.50	U
314	E	CR	1	QA-N-086-118	1	6.50	605.23	1.163	6.7	22	52.21	0.00	3.00	U
315	E	CR	1	QA-N-086-126	1	6.83	714.59	0.243	1.1	20	63.73	0.00	3.00	U
316	E	CR	1	QA-N-111-312	3	7.16	676.90	2.047	6.1	6	45.63	0.52	3.75	U
317	E	CR	1	QA-N-111-315	3	7.28	696.11	2.008	8.7	5	45.61	0.52	4.25	R
318	E	CR	1	TA-N-042-104	1	6.88	329.60	10.436	7.9	4	17.93	0.00	3.50	U
319	E	NW	1	CN-N-031-122	1	6.99	212.70	6.103	9.3	2	33.38	0.00	3.50	U
320	E	NW	1	CN-S-006-208	2	6.72	219.72	10.467	7.4	3	24.25	1.73	3.25	U
321	E	NW	1	DO-S-003-202	2	6.82	103.11	10.711	8.4	2	29.94	0.86	4.50	U
322	E	NW	1	DO-S-006-101	1	6.67	166.81	3.390	7.1	16	28.35	0.00	3.25	U
323	E	NW	1	DO-S-006-115	1	6.74	134.57	9.594	7.9	3	27.72	0.93	2.25	U
324	E	NW	1	DO-S-029-103	1	6.39	227.59	16.162	4.2	10	38.54	3.30	3.00	U
325	E	NW	1	DO-S-035-111	1	6.62	189.59	1.823	5.7	5	37.76	0.00	2.50	U
326	E	NW	1	SO-S-005-109	1	6.56	453.41	1.984	7.0	8	68.00	7.00	2.00	D
327	E	NW	1	WI-S-023-112	1	6.52	90.79	0.520	7.0	8	45.00	15.00	3.00	U
328	E	NW	1	WI-S-075-206	2	6.65	263.10	1.428	5.7	6	40.00	20.00	3.75	U

Sampling Year=96

OBS	REGION	BASIN	COASTAL	SITE	ORDER	PH_FLD	ANC	NO3	DO	DOC	FOREST	URBAN	FISHIBI	CLASS
418	C	BU	1	HA-N-009-105	1	7.03	669.80	1.096	8.8	5.2	49.51	26.21	.	
419	C	BU	1	HA-N-018-103	1	7.46	591.20	0.688	8.3	4.5	15.14	2.70	.	
420	C	BU	1	HA-N-036-206	2	7.53	510.80	1.018	9.3	3.4	44.47	5.08	3.50	U
421	C	BU	1	HA-N-040-307	3	7.74	453.80	2.496	9.0	1.6	39.73	6.81	3.50	U

Classification of Coastal Plain streams as degraded, reference, and unclassified.

Sampling Year=96
(continued)

OBS	REGION	BASIN	COASTAL	SITE	ORDER	PH_FLD	ANC	NO3	DO	DOC	FOREST	URBAN	FISHIBI	CLASS
422	C	BU	1	HA-N-052-202	2	7.29	429.00	2.318	11.0	2.1	52.78	5.56	4.50	R
423	C	BU	1	HA-N-067-111	1	7.08	382.80	0.694	9.0	1.2	56.05	8.63	3.00	U
424	C	BU	1	HA-N-068-301	3	7.71	807.10	2.246	10.0	2.4	27.13	19.51	4.50	R
425	C	BU	1	HA-N-068-308	3	7.70	784.30	2.178	10.0	2.1	27.55	19.29	4.50	R
426	C	BU	1	HA-N-086-201	2	7.72	450.60	3.254	11.9	2.3	26.08	4.97	3.75	U
427	C	BU	1	HA-N-092-304	3	7.03	484.10	2.652	9.1	1.7	38.94	6.98	4.50	R
428	C	BU	1	HA-N-099-305	3	8.82	666.30	2.248	10.3	2.0	31.40	15.64	4.75	R
482	C	PP	1	AA-N-020-124	1	6.15	55.90	0.256	6.5	4.9	69.75	11.11	.	
483	C	PP	1	AA-N-186-115	1	6.11	729.00	2.379	8.8	11.8	14.29	80.41	.	
484	C	PP	1	AA-N-262-101	1	6.78	897.90	1.888	8.6	14.6	7.57	89.90	1.00	D
485	C	PP	1	AA-N-323-225	2	6.47	321.60	1.552	8.6	4.9	33.64	11.71	3.25	U
486	C	PP	1	BA-N-001-211	2	7.40	841.40	0.682	8.1	8.3	21.77	60.41	2.00	D
487	C	PP	1	BA-N-045-223	2	7.22	1116.00	1.455	7.5	6.1	11.30	76.36	3.00	U
488	C	PP	1	BA-N-047-128	1	7.53	668.40	0.471	7.9	14.4	18.29	73.88	1.50	D
489	C	PP	1	BA-N-057-113	1	7.15	1887.20	1.223	1.0	8.2	13.23	72.42	1.00	U
490	C	PP	1	BA-N-065-215	2	7.42	1363.70	1.451	8.9	5.2	22.26	62.02	2.50	U
504	C	PP	1	BC-N-012-120	1	7.35	1186.40	0.177	8.5	2.8	19.87	74.94	1.00	D
505	C	PP	1	BC-N-014-217	2	7.46	592.50	0.799	7.8	8.8	7.87	88.57	2.25	U
506	C	PP	1	BC-N-015-202	2	7.06	947.10	1.682	7.6	3.2	12.57	77.28	1.75	D
540	C	PP	1	HO-N-019-304	3	7.64	1021.80	0.844	9.2	4.9	51.13	21.21	3.00	U
547	E	CK	1	CN-N-020-109	1	6.64	95.40	4.064	7.6	6.6	25.64	0.71	3.50	U
548	E	CK	1	CN-N-024-113	1	6.77	100.30	0.598	7.3	15.9	38.99	0.00	2.50	U
549	E	CK	1	CN-N-039-108	1	6.51	191.50	1.627	7.7	9.1	34.77	0.00	3.50	U
550	E	CK	1	CN-N-041-205	2	6.87	34.90	3.760	9.5	6.9	26.13	0.03	2.50	U
551	E	CK	1	CN-N-050-102	1	6.63	167.90	0.880	9.4	5.6	39.41	2.18	3.50	U
552	E	CK	1	CN-N-051-202	2	6.78	165.40	4.395	9.7	5.8	22.93	0.02	3.50	U
553	E	CK	1	CN-S-002-111	1	6.72	104.40	8.614	9.2	4.0	13.38	0.77	3.00	U
554	E	CK	1	QA-N-040-206	2	7.05	335.70	4.593	9.4	7.9	22.47	0.24	4.00	U
555	E	CK	1	QA-N-047-204	2	6.59	240.30	4.574	8.1	7.7	22.09	1.08	4.25	U
556	E	CK	1	QA-N-098-301	3	6.82	222.10	3.722	9.6	7.2	23.23	0.52	4.75	U
557	E	CK	1	QA-N-098-302	3	6.85	216.70	3.617	12.2	7.1	23.19	0.52	4.75	U
558	E	CK	1	QA-N-098-307	3	6.38	201.50	3.635	10.2	6.6	22.92	0.51	4.50	U
559	E	CK	1	QA-N-098-308	3	6.83	193.70	3.651	10.0	6.2	22.98	0.51	4.25	U
560	E	CK	1	QA-N-098-309	3	6.97	224.80	3.617	13.8	6.9	22.87	0.49	4.75	U
561	E	CK	1	QA-N-103-203	2	6.62	246.90	2.549	9.4	11.2	34.76	0.09	3.75	U
562	E	CK	1	TA-N-017-104	1	6.29	210.50	9.879	9.6	3.4	18.81	2.31	4.00	U

Classification of Coastal Plain streams as degraded, reference, and unclassified.

Sampling Year=96
(continued)

OBS	REGION	BASIN	COASTAL	SITE	ORDER	PH_FLD	ANC	NO3	DO	DOC	FOREST	URBAN	FISHIBI	CLASS
563	E	CK	1	TA-N-035-105	1	6.38	377.40	12.915	9.2	5.8	22.65	6.03	4.00	U
564	E	CK	1	TA-N-053-201	2	6.90	291.10	5.290	8.4	4.7	11.59	0.00	3.50	U
565	E	EL	1	CE-N-021-302	3	8.39	570.60	2.384	9.9	3.0	30.42	2.82	5.00	R
566	E	EL	1	CE-N-029-206	2	7.51	348.20	2.228	8.7	2.4	42.92	0.55	4.00	R
567	E	EL	1	CE-N-033-301	3	7.59	428.90	3.195	10.2	2.6	31.46	2.90	4.75	R
568	E	EL	1	CE-N-040-119	1	6.71	334.70	7.639	8.6	0.9	8.68	0.00	2.50	U

Classification of Non-Coastal Plain streams as degraded, reference, and unclassified.

Sampling Year=94

OBS	REGION	BASIN	COASTAL	SITE	ORDER	PH_FLD	ANC	NO3	DO	DOC	FOREST	URBAN	FISHIBI	CLASS
76	E	SQ	0	BA-P-080-2	3	6.89	418.09	5.398	10.5	1	100.0	0.00	.	
77	E	SQ	0	CE-P-006-1	2	5.79	355.40	2.813	10.1	3	35.89	15.13	3.25	U
78	E	SQ	0	CE-P-006-4	2	6.38	355.40	2.813	9.3	3	35.93	15.13	3.25	U
79	E	SQ	0	CE-P-074-1	1	6.43	398.50	2.810	8.5	2	30.38	12.83	.	
80	E	SQ	0	CE-P-074-2	1	6.41	398.50	2.810	8.8	2	25.40	36.43	2.25	U
81	E	SQ	0	CE-P-078-1	1	5.28	317.91	3.007	8.9	2	31.28	9.16	3.00	U
82	E	SQ	0	CE-P-078-2	1	6.48	317.91	3.007	8.1	2	33.05	12.91	3.75	U
83	E	SQ	0	HA-P-008-1	2	5.81	331.68	2.148	11.1	10	41.44	10.03	4.00	R
84	E	SQ	0	HA-P-008-3	2	6.81	331.68	2.148	9.9	10	42.45	10.71	4.25	R
85	E	SQ	0	HA-P-041-1	1	6.18	335.08	2.333	8.8	1	20.00	10.00	.	
86	E	SQ	0	HA-P-041-2	1	5.26	335.08	2.333	5.3	1	2.56	3.59	.	
87	E	SQ	0	HA-P-071-1	3	6.31	288.03	5.486	9.3	2	19.61	5.73	4.25	U
88	E	SQ	0	HA-P-071-2	3	5.90	288.03	5.486	8.9	2	19.23	6.03	3.75	U
89	E	SQ	0	HA-P-078-4	1	6.55	464.56	5.089	9.3	4	6.99	3.81	2.75	U
90	E	SQ	0	HA-P-078-6	1	6.53	464.56	5.089	8.3	4	1.32	5.19	3.00	U
91	E	SQ	0	HA-P-087-1	2	6.72	400.38	4.843	8.5	3	13.95	3.47	3.75	U
92	E	SQ	0	HA-P-087-2	2	6.47	400.38	4.843	10.0	3	12.98	3.37	4.00	U
93	E	SQ	0	HA-P-131-1	2	5.86	178.39	3.476	8.4	2	44.30	11.09	4.00	U
94	E	SQ	0	HA-P-131-3	2	6.00	178.39	3.476	7.2	2	45.24	11.19	4.00	R
95	E	SQ	0	HA-P-174-2	3	6.47	269.67	4.776	9.0	2	21.97	6.49	4.00	U
96	E	SQ	0	HA-P-205-1	1	5.86	634.37	1.573	9.7	2	56.29	17.84	3.50	U
97	E	SQ	0	HA-P-205-2	1	6.55	634.37	1.573	9.1	2	57.62	16.93	3.50	U
98	E	SQ	0	HA-P-207-1	2	6.54	405.40	4.831	8.9	3	13.12	5.20	4.00	U
99	E	SQ	0	HA-P-207-2	2	6.24	405.40	4.831	9.2	3	12.97	5.14	3.75	U
100	E	SQ	0	HA-P-216-1	1	6.13	571.67	0.947	5.0	2	44.54	43.45	2.00	D
101	E	SQ	0	HA-P-216-2	1	6.04	571.67	0.947	8.7	2	46.22	20.36	4.50	U
102	E	SQ	0	HA-P-225-1	1	5.87	306.49	1.808	9.6	2	52.35	17.00	3.50	U
103	E	SQ	0	HA-P-225-2	1	4.70	306.49	1.808	9.3	2	24.22	7.69	.	
104	E	SQ	0	HA-P-244-1	1	5.95	350.14	2.977	8.9	2	22.63	21.87	3.25	U
105	E	SQ	0	HA-P-244-2	1	6.46	350.14	2.977	8.2	2	19.46	16.16	3.75	U
106	W	PW	0	MO-P-006-1	2	7.31	324.26	3.830	9.4	2	18.64	25.60	4.25	U
107	W	PW	0	MO-P-006-2	2	8.08	324.26	3.830	5.7	2	19.30	9.31	4.25	U
108	W	PW	0	MO-P-022-3	1	7.11	359.23	0.787	5.0	3	13.92	1.92	3.25	U
109	W	PW	0	MO-P-025-1	1	7.33	1177.35	1.874	6.1	4	0.00	100.1	.	
110	W	PW	0	MO-P-025-2	1	6.20	1177.35	1.874	6.9	4	8.02	66.64	3.00	U
111	W	PW	0	MO-P-038-1	3	7.60	843.03	2.506	7.6	2	22.55	31.99	4.25	U
112	W	PW	0	MO-P-053-2	2	7.35	366.50	2.874	10.0	2	20.46	47.15	4.50	U

Classification of Non-Coastal Plain streams as degraded, reference, and unclassified.

Sampling Year=94
(continued)

OBS	REGION	BASIN	COASTAL	SITE	ORDER	PH_FLD	ANC	NO3	DO	DOC	FOREST	URBAN	FISHIBI	CLASS
113	W	PW	0	MO-P-053-7	2	7.50	366.50	2.874	8.5	2	20.49	47.23	4.25	U
114	W	PW	0	MO-P-069-5	1	7.20	587.39	5.090	6.3	4	17.01	57.12	3.25	U
115	W	PW	0	MO-P-086-1	3	7.45	909.38	1.726	7.3	3	19.67	70.68	3.50	U
116	W	PW	0	MO-P-086-2	3	7.47	909.38	1.726	8.1	3	20.17	70.30	3.50	U
117	W	PW	0	MO-P-099-1	1	7.42	822.29	2.319	7.3	5	25.92	72.79	1.00	D
118	W	PW	0	MO-P-099-2	1	7.42	822.29	2.319	7.3	5	26.63	72.15	1.25	D
119	W	PW	0	MO-P-103-1	1	7.70	1124.00	2.752	7.1	1	5.37	94.65	4.25	U
120	W	PW	0	MO-P-103-2	1	7.70	1124.00	2.752	7.1	1	5.21	94.62	4.25	U
121	W	PW	0	MO-P-118-1	3	7.50	350.51	3.302	8.3	2	18.02	27.25	4.25	U
122	W	PW	0	MO-P-118-2	3	7.11	350.51	3.302	8.2	2	18.06	27.39	4.25	U
123	W	PW	0	MO-P-180-1	2	7.86	834.22	2.814	7.9	2	19.03	25.48	4.50	U
124	W	PW	0	MO-P-192-1	1	7.30	904.77	1.715	7.0	2	12.51	61.99	1.00	D
125	W	PW	0	MO-P-192-2	1	7.30	904.77	1.715	7.0	2	22.52	37.43	1.00	D
126	W	PW	0	MO-P-233-1	3	7.57	751.24	1.797	8.2	4	22.57	37.02	4.25	U
127	W	PW	0	MO-P-233-2	3	7.51	751.24	1.797	7.8	4	22.51	36.71	4.25	U
128	W	PW	0	MO-P-265-4	1	6.93	314.01	2.460	8.4	3	0.00	41.14	.	
129	W	PW	0	MO-P-265-5	1	6.76	314.01	2.460	5.7	3	0.00	32.75	.	
130	W	PW	0	MO-P-286-1	2	7.75	1155.76	3.456	8.2	2	15.84	48.07	3.25	U
131	W	PW	0	MO-P-286-2	2	7.78	1155.76	3.456	7.8	2	15.56	50.11	3.25	U
132	W	PW	0	MO-P-296-2	2	8.09	860.00	4.348	7.6	2	13.41	58.81	3.75	U
133	W	PW	0	MO-P-361-8	2	7.56	669.87	0.815	6.8	4	20.36	64.75	4.25	U
134	W	PW	0	MO-P-419-2	1	6.55	173.06	4.348	9.4	2	6.47	2.34	.	
135	W	PW	0	MO-P-432-1	1	7.77	1491.22	2.070	6.8	5	5.10	94.94	1.00	D
136	W	PW	0	MO-P-452-1	1	7.75	979.14	2.358	6.9	2	0.00	99.84	.	
137	W	PW	0	MO-P-452-2	1	7.75	979.14	2.358	6.9	2	0.00	99.46	.	
138	W	PW	0	MO-P-454-3	1	8.10	1495.97	2.993	7.1	3	9.06	39.36	4.00	U
139	W	PW	0	MO-P-470-1	2	7.40	874.51	1.989	6.2	3	14.65	63.22	4.25	U
140	W	PW	0	MO-P-470-2	2	7.26	874.51	1.989	6.7	3	15.07	63.36	4.25	U
141	W	PW	0	MO-P-480-3	3	7.87	998.08	1.955	9.5	3	25.00	70.00	4.00	U
142	W	PW	0	MO-P-490-2	1	7.14	512.52	4.577	7.2	2	33.96	13.78	.	
143	W	PW	0	MO-P-500-1	2	7.68	1037.75	1.678	7.9	4	14.13	85.55	3.00	U
144	W	PW	0	MO-P-500-2	2	7.54	1037.75	1.678	7.7	4	12.38	87.33	3.50	U
145	W	PW	0	MO-P-501-1	1	7.43	1458.14	0.191	1.6	4	30.34	73.72	.	
146	W	PW	0	MO-P-501-3	1	7.08	1458.14	0.191	2.9	4	28.30	75.14	.	
147	W	PW	0	MO-P-508-2	1	7.02	936.99	1.738	7.2	2	29.02	32.54	4.25	U
148	W	PW	0	MO-P-508-3	1	8.73	936.99	1.738	7.3	2	30.59	31.85	4.25	U

Classification of Non-Coastal Plain streams as degraded, reference, and unclassified.

Sampling Year=94
(continued)

OBS	REGION	BASIN	COASTAL	SITE	ORDER	PH_FLD	ANC	NO3	DO	DOC	FOREST	URBAN	FISHIBI	CLASS
163	W	YG	0	GA-A-011-2	3	6.75	-8.74	0.090	8.0	3	66.05	7.23	2.25	U
164	W	YG	0	GA-A-021-1	1	4.15	-85.40	0.050	7.8	3	99.66	0.00	1.00	U
165	W	YG	0	GA-A-021-2	1	4.05	-85.40	0.050	6.7	3	99.43	0.00	1.00	U
166	W	YG	0	GA-A-089-1	1	6.75	93.57	0.924	6.9	2	26.38	0.00	2.75	U
167	W	YG	0	GA-A-089-2	1	6.68	93.57	0.924	8.2	2	25.36	0.00	2.75	U
168	W	YG	0	GA-A-143-1	1	5.99	-28.23	0.126	3.9	2	59.47	6.36	1.00	U
169	W	YG	0	GA-A-143-5	1	6.46	-28.23	0.126	1.8	2	55.79	10.05	2.00	U
170	W	YG	0	GA-A-152-1	2	4.40	-7.62	0.179	8.3	1	93.41	7.49	.	
171	W	YG	0	GA-A-152-5	2	5.14	-10.42	0.280	8.3	1	85.38	11.07	1.00	U
172	W	YG	0	GA-A-181-1	3	7.25	96.67	0.441	7.2	1	67.07	22.75	2.25	U
173	W	YG	0	GA-A-181-2	3	7.28	96.67	0.441	7.4	1	61.60	21.77	2.75	U
174	W	YG	0	GA-A-235-4	2	6.70	131.80	0.834	7.1	3	25.64	1.65	3.00	U
175	W	YG	0	GA-A-235-5	2	6.25	131.80	0.834	6.1	3	26.83	1.62	3.25	U
176	W	YG	0	GA-A-347-1	1	4.45	-36.79	0.122	6.7	1	100.0	0.00	.	
177	W	YG	0	GA-A-520-1	1	4.98	-12.39	0.142	5.8	1	0.00	6.92	.	
178	W	YG	0	GA-A-520-2	1	4.98	-12.39	0.142	5.8	1	0.00	7.09	.	
179	W	YG	0	GA-A-547-5	1	7.16	64.99	0.272	7.9	0	86.89	1.32	3.25	U
180	W	YG	0	GA-A-548-2	3	6.82	2.61	0.095	5.8	3	58.56	8.87	2.00	D
181	W	YG	0	GA-A-553-1	2	4.55	-63.27	0.000	5.7	3	82.67	10.55	1.00	U
182	W	YG	0	GA-A-553-2	2	4.57	-63.27	0.000	5.2	3	84.03	10.04	1.00	U
183	W	YG	0	GA-A-557-1	1	6.20	73.44	1.147	6.6	2	26.32	0.00	2.50	U
184	W	YG	0	GA-A-557-2	1	6.30	73.44	1.147	6.6	2	21.84	0.00	2.50	U

Sampling Year=95

OBS	REGION	BASIN	COASTAL	SITE	ORDER	PH_FLD	ANC	NO3	DO	DOC	FOREST	URBAN	FISHIBI	CLASS
234	C	PP	0	BA-P-002-319	3	7.93	1930.59	1.808	8.6	1	34.76	41.20	3.25	U
235	C	PP	0	BA-P-008-101	1	7.98	513.17	1.493	8.0	1	57.42	22.30	4.50	U

Classification of Non-Coastal Plain streams as degraded, reference, and unclassified.

Sampling Year=95
(continued)

OBS	REGION	BASIN	COASTAL	SITE	ORDER	PH_FLD	ANC	NO3	DO	DOC	FOREST	URBAN	FISHIBI	CLASS
236	C	PP	0	BA-P-077-322	3	7.50	1058.19	1.368	8.2	2	38.41	29.43	3.50	U
237	C	PP	0	BA-P-107-123	1	7.87	609.74	0.502	7.0	2	48.32	14.10	.	
238	C	PP	0	BA-P-206-108	1	7.76	632.81	2.470	9.3	1	49.23	19.38	4.25	R
239	C	PP	0	BA-P-234-109	1	7.54	218.57	2.509	8.7	1	21.70	66.56	.	
240	C	PP	0	BA-P-291-217	2	7.48	694.39	2.186	9.4	1	36.32	30.31	4.25	U
241	C	PP	0	BA-P-313-204	2	7.49	925.37	2.086	8.4	2	48.40	26.50	4.00	U
242	C	PP	0	BA-P-313-215	2	7.53	868.02	1.984	8.6	2	48.79	26.18	4.25	U
243	C	PP	0	BA-P-331-315	3	7.33	1424.13	1.787	8.2	2	30.58	53.77	3.00	U
244	C	PP	0	BA-P-346-321	3	8.34	1969.44	1.871	10.2	2	31.31	46.84	3.50	U
245	C	PP	0	BA-P-376-105	1	7.25	419.38	6.696	8.0	2	3.31	87.60	.	
246	C	PP	0	BA-P-415-119	1	7.58	1890.36	0.260	8.9	2	42.52	54.36	1.00	D
247	C	PP	0	BA-P-464-117	1	7.52	2010.77	0.856	7.8	2	17.27	82.86	1.00	D
248	C	PP	0	BA-P-478-325	3	8.02	1369.80	1.869	9.1	2	32.00	51.04	2.75	U
252	C	PP	0	BC-P-003-205	2	8.11	1272.49	2.642	8.6	3	7.22	92.30	1.50	D
253	C	PP	0	CR-P-003-316	3	7.09	372.91	4.703	8.3	0	19.98	20.56	5.00	U
254	C	PP	0	CR-P-038-227	2	7.81	1829.80	6.283	7.8	2	5.34	39.68	4.25	U
255	C	PP	0	CR-P-050-106	1	7.58	561.95	9.066	9.2	2	8.52	26.21	3.00	U
256	C	PP	0	CR-P-077-309	3	8.35	626.88	4.686	9.2	2	25.24	23.85	4.25	U
257	C	PP	0	CR-P-112-122	1	7.42	598.49	3.011	8.5	0	1.13	54.99	.	
258	C	PP	0	CR-P-115-111	1	7.51	803.41	3.492	8.3	0	27.11	26.02	4.50	U
259	C	PP	0	CR-P-138-116	1	7.46	303.92	8.211	8.1	2	0.95	5.77	.	
260	C	PP	0	CR-P-143-218	2	7.39	443.96	3.473	9.1	2	20.43	16.54	5.00	U
261	C	PP	0	CR-P-152-318	3	7.56	635.35	4.600	8.1	1	24.21	21.12	4.50	U
262	C	PP	0	CR-P-166-221	2	7.48	314.86	4.038	9.5	0	40.88	4.75	4.25	R
263	C	PP	0	CR-P-175-113	1	7.43	515.21	2.764	9.0	2	33.80	4.85	4.75	R
264	C	PP	0	CR-P-197-211	2	7.49	420.70	4.879	9.0	0	22.49	8.59	4.50	U
265	C	PP	0	CR-P-224-226	2	7.46	352.62	4.844	7.4	1	26.86	16.76	4.50	U
266	C	PP	0	CR-P-260-212	2	7.04	482.31	5.659	8.1	1	7.92	26.36	5.00	U
267	C	PP	0	CR-P-270-104	1	7.21	638.59	8.138	8.3	1	16.93	0.01	4.75	U
268	C	PP	0	CR-P-281-127	1	7.78	598.28	4.952	5.7	2	23.99	13.36	4.75	U
269	C	PP	0	CR-P-294-124	1	7.49	295.56	6.936	8.9	0	12.04	16.31	3.75	U
270	C	PP	0	CR-P-362-302	3	8.29	695.06	2.171	9.2	2	49.40	18.84	5.00	R
271	C	PP	0	CR-P-362-304	3	7.86	573.40	2.172	8.8	2	49.42	18.83	5.00	R
272	C	PP	0	CR-P-362-317	3	7.05	694.59	2.033	7.6	2	36.52	31.18	.	
273	C	PP	0	CR-P-398-222	2	7.46	312.08	4.162	8.2	4	22.95	15.05	4.50	U
274	C	PP	0	CR-P-402-121	1	7.22	292.33	6.064	8.7	1	13.15	19.00	4.25	U

Classification of Non-Coastal Plain streams as degraded, reference, and unclassified.

Sampling Year=95
(continued)

OBS	REGION	BASIN	COASTAL	SITE	ORDER	PH_FLD	ANC	NO3	DO	DOC	FOREST	URBAN	FISHIBI	CLASS
275	C	PP	0	CR-P-419-214	2	7.24	347.53	4.468	8.6	2	26.09	10.24	5.00	U
276	C	PP	0	CR-P-999-323	3	7.27	413.21	4.812	9.2	2	25.00	35.00	5.00	U
279	C	PP	0	HO-P-036-314	3	8.16	425.34	4.189	9.8	2	29.14	15.96	3.50	U
280	C	PP	0	HO-P-068-220	2	7.57	734.44	1.299	8.4	2	42.00	17.08	3.50	U
281	C	PP	0	HO-P-108-313	3	7.77	574.14	4.330	9.4	2	28.67	16.08	4.75	U
282	C	PP	0	HO-P-244-310	3	7.26	472.95	4.276	7.7	2	28.35	16.18	4.75	U
329	W	UP	0	AL-A-020-228	2	5.90	93.73	0.143	1.7	2	100.3	0.00	2.75	U
330	W	UP	0	AL-A-027-205	2	6.84	183.60	0.171	8.2	2	95.93	0.00	1.00	D
331	W	UP	0	AL-A-027-209	2	6.70	175.46	0.185	7.6	3	96.36	0.00	1.75	D
332	W	UP	0	AL-A-143-226	2	7.07	138.19	0.577	9.2	2	76.54	0.00	2.25	U
333	W	UP	0	AL-A-146-301	3	.	177.81	0.293	9.3	2	90.00	0.00	4.25	U
334	W	UP	0	AL-A-167-230	2	6.44	131.04	0.159	5.7	1	96.17	0.00	2.75	U
335	W	UP	0	AL-A-171-206	2	6.74	92.90	0.115	6.4	2	93.23	0.00	1.50	D
336	W	UP	0	AL-A-177-232	2	6.41	94.23	0.160	3.4	2	98.79	0.00	3.50	U
337	W	UP	0	AL-A-199-122	1	6.08	74.56	0.354	8.4	2	99.99	0.00	.	
338	W	UP	0	AL-A-215-112	1	6.55	231.11	0.144	6.8	2	99.61	0.00	.	
339	W	UP	0	AL-A-244-227	2	6.61	144.01	0.120	3.8	2	100.1	0.00	1.25	D
340	W	UP	0	AL-A-248-213	2	7.33	291.05	0.135	7.9	2	80.00	0.00	2.75	U
341	W	UP	0	AL-A-248-234	2	6.82	400.21	0.000	8.4	5	82.00	0.00	3.00	U
342	W	UP	0	AL-A-255-108	1	6.54	255.68	0.507	6.5	2	100.3	0.00	.	
343	W	UP	0	AL-A-318-126	1	6.19	59.65	0.210	8.1	2	78.41	0.00	1.00	D
344	W	UP	0	AL-A-392-316	3	7.12	423.47	0.753	8.3	2	71.16	0.00	3.50	U
345	W	UP	0	AL-A-392-318	3	6.76	430.90	0.639	5.6	2	71.16	0.00	4.25	R
346	W	UP	0	AL-A-419-106	1	6.55	227.61	0.328	6.8	3	86.61	0.00	.	
347	W	UP	0	AL-A-500-103	1	6.08	125.31	0.153	6.1	2	100.8	0.00	.	
348	W	UP	0	AL-A-553-306	3	8.01	449.64	0.248	9.2	2	64.00	1.72	4.50	R
349	W	UP	0	AL-A-635-113	1	5.81	131.40	0.114	4.8	2	100.4	0.00	.	
350	W	UP	0	AL-A-646-207	2	6.58	313.47	0.169	2.7	2	99.93	0.00	1.00	D
351	W	UP	0	AL-A-731-313	3	7.60	4286.44	1.626	9.0	0	70.73	0.00	3.25	U
352	W	UP	0	WA-A-003-308	3	7.18	335.59	0.383	8.3	3	79.23	3.87	4.00	R
353	W	UP	0	WA-A-005-118	1	6.48	165.59	2.849	8.3	3	42.32	5.69	.	
354	W	UP	0	WA-A-045-127	1	5.99	101.92	0.390	6.6	3	96.13	5.14	.	
355	W	UP	0	WA-A-053-223	2	7.10	442.82	0.332	6.8	3	65.32	0.00	4.25	R
356	W	UP	0	WA-A-068-101	1	6.27	92.49	0.648	7.6	2	84.75	0.00	.	
357	W	UP	0	WA-A-089-312	3	8.27	180.07	0.893	9.1	2	67.89	0.00	4.25	R
358	W	UP	0	WA-A-101-219	2	6.72	216.86	4.986	5.1	2	21.62	0.00	.	

Classification of Non-Coastal Plain streams as degraded, reference, and unclassified.

Sampling Year=95
(continued)

OBS	REGION	BASIN	COASTAL	SITE	ORDER	PH_FLD	ANC	NO3	DO	DOC	FOREST	URBAN	FISHIBI	CLASS
359	W	UP	0	WA-A-106-124	1	7.22	434.92	0.532	8.2	0	91.88	0.00	.	
360	W	UP	0	WA-A-133-204	2	6.35	337.24	0.201	7.4	3	90.09	1.60	3.00	U
361	W	UP	0	WA-A-139-235	2	7.80	3384.35	0.886	8.2	2	10.71	0.00	3.25	U
362	W	UP	0	WA-A-144-311	3	6.82	182.92	0.720	9.0	2	71.53	0.00	4.00	R
363	W	UP	0	WA-V-003-123	1	7.45	5814.56	5.928	8.5	2	45.07	2.63	2.00	D
364	W	UP	0	WA-V-062-212	2	8.00	3301.25	3.933	8.5	2	40.57	9.82	4.50	R
365	W	UP	0	WA-V-063-201	2	7.58	1976.40	3.383	9.7	2	37.36	3.68	4.00	R
366	W	UP	0	WA-V-072-104	1	7.39	175.23	0.368	6.6	26	68.05	29.17	.	
367	W	UP	0	WA-V-075-220	2	7.52	1126.22	1.038	9.1	2	45.24	9.27	3.25	U
368	W	UP	0	WA-V-077-310	3	8.12	5334.01	4.676	7.7	2	12.24	18.67	4.00	U
369	W	UP	0	WA-V-084-116	1	7.50	530.76	1.897	8.0	2	33.45	1.07	5.00	R
370	W	UP	0	WA-V-105-215	2	8.24	2966.92	2.972	10.2	3	57.24	11.56	4.00	R
371	W	UP	0	WA-V-118-117	1	6.54	49.37	0.246	9.0	2	65.79	9.13	4.00	U
372	W	UP	0	WA-V-120-233	2	8.06	1484.52	0.964	6.2	3	66.14	5.27	5.00	R
373	W	UP	0	WA-V-131-224	2	8.85	4723.34	8.238	9.3	2	2.00	16.16	2.75	U
374	W	UP	0	WA-V-157-111	1	8.26	3618.20	3.216	12.0	2	36.78	0.99	3.50	U
375	W	UP	0	WA-V-161-214	2	7.31	286.68	0.418	7.6	2	89.26	3.98	4.25	R
376	W	UP	0	WA-V-164-202	2	8.99	4851.26	8.657	8.7	2	3.80	16.13	4.00	U
377	W	UP	0	WA-V-170-217	2	7.73	2325.01	0.176	8.8	2	76.13	7.17	4.75	R
378	W	UP	0	WA-V-174-236	2	7.26	5715.83	7.195	9.4	2	4.25	2.88	2.75	U
379	W	UP	0	WA-V-175-208	2	6.96	4525.44	6.441	9.4	2	12.04	5.71	2.75	U
380	W	UP	0	WA-V-175-216	2	7.89	4477.51	4.557	8.4	0	9.81	3.72	3.50	U
381	W	UP	0	WA-V-176-109	1	8.40	5110.95	6.625	9.0	2	9.48	18.75	1.50	D
382	W	UP	0	WA-V-186-210	2	7.71	1336.93	2.284	9.2	2	33.10	4.45	4.50	R
383	W	UP	0	WA-V-192-115	1	7.39	5736.67	5.226	6.7	2	8.26	82.15	1.75	D
384	W	UP	0	WA-V-193-110	1	8.67	4007.08	2.724	5.4	2	11.94	4.51	1.00	D
385	W	YG	0	GA-A-001-105	1	6.17	144.41	0.230	4.5	2	85.36	0.00	.	
386	W	YG	0	GA-A-010-205	2	6.60	276.46	0.663	6.5	5	33.37	0.00	2.50	U
387	W	YG	0	GA-A-062-202	2	7.04	171.70	0.681	7.7	1	80.40	0.59	4.00	R
388	W	YG	0	GA-A-062-222	2	7.20	178.53	0.634	8.5	1	80.40	0.59	3.75	U
389	W	YG	0	GA-A-111-316	3	7.22	356.37	0.378	6.9	2	61.40	4.80	3.25	U
390	W	YG	0	GA-A-120-103	1	7.16	262.18	0.678	5.9	1	64.57	0.00	4.00	R
391	W	YG	0	GA-A-128-217	2	6.55	245.36	0.551	7.9	2	64.44	0.00	3.50	U
392	W	YG	0	GA-A-141-213	2	6.66	157.48	0.587	8.1	2	51.48	3.91	3.50	U
393	W	YG	0	GA-A-142-118	1	6.60	302.70	0.779	7.5	4	36.96	0.00	.	
394	W	YG	0	GA-A-179-113	1	7.15	464.80	0.606	7.1	2	28.83	0.00	.	

Classification of Non-Coastal Plain streams as degraded, reference, and unclassified.

Sampling Year=95
(continued)

OBS	REGION	BASIN	COASTAL	SITE	ORDER	PH_FLD	ANC	NO3	DO	DOC	FOREST	URBAN	FISHIBI	CLASS
395	W	YG	0	GA-A-181-303	3	7.91	290.09	0.519	9.1	2	61.29	22.18	1.75	D
396	W	YG	0	GA-A-185-309	3	6.80	375.20	0.708	7.5	3	36.35	0.74	3.00	U
397	W	YG	0	GA-A-185-321	3	6.89	389.08	0.715	7.3	3	36.80	0.73	2.75	U
398	W	YG	0	GA-A-235-215	2	6.60	158.04	0.672	7.3	2	26.14	1.64	2.25	U
399	W	YG	0	GA-A-236-216	2	6.91	197.17	0.423	6.9	0	50.38	2.79	3.50	U
400	W	YG	0	GA-A-236-218	2	7.12	158.71	0.461	7.1	0	40.62	0.70	5.00	R
401	W	YG	0	GA-A-326-106	1	7.05	222.28	0.334	7.0	4	74.59	2.53	3.75	U
402	W	YG	0	GA-A-351-117	1	6.40	136.70	0.673	7.8	3	53.93	18.46	4.25	R
403	W	YG	0	GA-A-358-115	1	6.59	176.95	1.979	8.2	2	45.59	2.50	3.25	U
404	W	YG	0	GA-A-373-220	2	6.50	279.84	0.452	7.2	2	40.97	5.32	3.75	U
405	W	YG	0	GA-A-405-112	1	8.53	334.85	0.749	8.8	6	48.60	0.00	3.00	U
406	W	YG	0	GA-A-407-314	3	6.86	114.05	0.331	7.9	1	70.50	1.39	4.75	R
407	W	YG	0	GA-A-432-315	3	7.30	160.66	0.647	7.4	1	86.06	0.30	3.75	U
408	W	YG	0	GA-A-453-310	3	7.43	276.76	0.454	7.2	1	70.81	3.41	4.00	R
409	W	YG	0	GA-A-457-114	1	6.76	278.36	0.592	6.8	1	74.75	3.28	4.25	R
410	W	YG	0	GA-A-493-109	1	6.94	109.37	0.269	6.4	2	71.51	2.40	4.50	R
411	W	YG	0	GA-A-505-210	2	6.85	110.87	0.262	6.1	3	69.45	1.41	3.25	U
412	W	YG	0	GA-A-511-322	3	7.00	51.45	0.275	6.5	2	72.78	1.81	3.75	U
413	W	YG	0	GA-A-521-108	1	7.03	161.93	0.570	6.9	1	76.40	0.72	2.75	U
414	W	YG	0	GA-A-545-301	3	6.73	85.71	0.291	7.4	1	71.87	2.69	3.50	U
415	W	YG	0	GA-A-548-317	3	7.13	43.50	0.141	5.6	3	59.22	9.07	1.00	D
416	W	YG	0	GA-A-560-201	2	7.24	354.28	0.456	8.2	2	55.79	3.19	3.50	U
417	W	YG	0	GA-A-563-318	3	6.85	13.07	0.252	6.4	2	83.70	0.00	3.00	U

Sampling Year=96

OBS	REGION	BASIN	COASTAL	SITE	ORDER	PH_FLD	ANC	NO3	DO	DOC	FOREST	URBAN	FISHIBI	CLASS
429	C	BU	0	HA-P-001-205	2	7.52	347.10	2.806	9.2	1.4	42.04	1.63	4.50	R

Classification of Non-Coastal Plain streams as degraded, reference, and unclassified.

Sampling Year=96
(continued)

OBS	REGION	BASIN	COASTAL	SITE	ORDER	PH_FLD	ANC	NO3	DO	DOC	FOREST	URBAN	FISHIBI	CLASS
430	C	BU	0	HA-P-038-106	1	7.73	1031.60	0.778	9.7	1.4	38.54	17.23	4.25	R
431	C	BU	0	HA-P-062-207	2	7.61	910.30	2.176	8.9	2.3	27.63	15.33	3.25	U
432	C	BU	0	HA-P-128-104	1	6.68	192.60	3.067	11.7	1.2	12.94	0.53	2.50	U
433	C	BU	0	HA-P-141-302	3	7.31	297.10	3.230	10.5	1.0	40.45	1.30	4.75	R
434	C	BU	0	HA-P-141-303	3	7.47	275.80	3.174	9.6	1.2	39.92	1.23	4.50	R
435	C	BU	0	HA-P-151-102	1	7.18	811.70	2.462	9.5	2.1	21.89	46.34	3.25	U
436	C	BU	0	HA-P-164-306	3	7.63	855.60	2.163	10.2	2.1	26.49	21.76	3.75	U
437	C	GU	0	BA-P-015-120	1	7.14	194.50	2.548	9.6	1.1	58.59	0.00	2.50	U
438	C	GU	0	BA-P-025-102	1	6.52	180.00	1.530	12.6	4.9	52.40	0.00	3.75	U
439	C	GU	0	BA-P-042-116	1	8.00	239.90	4.154	9.8	0.9	31.64	0.00	4.00	R
440	C	GU	0	BA-P-055-103	1	7.47	359.30	1.770	9.6	2.1	32.20	0.00	.	
441	C	GU	0	BA-P-057-209	2	7.71	488.50	2.298	9.1	1.4	56.45	2.83	3.00	U
442	C	GU	0	BA-P-065-117	1	7.01	311.40	4.948	10.2	1.0	12.42	0.67	.	
443	C	GU	0	BA-P-065-119	1	7.39	307.80	4.580	11.9	1.0	13.42	0.32	2.25	U
444	C	GU	0	BA-P-089-122	1	7.72	284.70	3.532	10.6	1.2	31.97	1.24	3.75	U
445	C	GU	0	BA-P-103-124	1	7.22	885.70	2.707	7.7	3.3	11.11	0.00	.	
446	C	GU	0	BA-P-116-114	1	7.27	881.30	4.816	10.2	1.1	7.78	0.00	.	
447	C	GU	0	BA-P-121-111	1	7.78	1086.20	1.600	11.2	1.7	78.39	10.99	.	
448	C	GU	0	BA-P-124-302	3	7.48	277.00	4.667	10.5	1.2	24.65	0.28	4.00	U
449	C	GU	0	BA-P-141-206	2	7.49	249.90	3.120	11.5	0.9	36.57	0.10	3.00	U
450	C	GU	0	BA-P-143-104	1	7.42	942.20	1.226	10.6	2.0	54.85	0.42	3.50	U
451	C	GU	0	BA-P-156-208	2	7.31	290.70	3.544	10.2	1.1	31.31	0.56	4.00	R
452	C	GU	0	BA-P-160-205	2	7.32	448.00	2.768	10.4	1.3	26.93	0.00	3.50	U
453	C	GU	0	BA-P-179-125	1	7.33	295.00	2.424	10.2	2.3	24.69	0.00	4.00	U
454	C	GU	0	BA-P-191-211	2	7.43	512.20	5.252	9.9	1.1	8.21	2.39	4.50	U
455	C	GU	0	BA-P-202-202	2	7.18	315.90	3.246	10.7	1.7	37.81	1.43	3.25	U
456	C	GU	0	BA-P-203-215	2	8.38	1525.90	1.927	11.0	1.9	61.06	2.82	3.50	U
457	C	GU	0	BA-P-215-305	3	8.81	515.60	2.687	11.2	2.3	28.44	0.33	3.75	U
458	C	GU	0	BA-P-218-313	3	6.72	272.00	4.908	10.2	1.1	21.93	0.31	3.75	U
459	C	GU	0	BA-P-238-311	3	7.45	268.30	5.266	10.6	1.2	20.86	0.33	4.00	U
460	C	GU	0	BA-P-242-210	2	7.16	352.40	4.173	10.2	1.5	23.46	0.00	3.75	U
461	C	GU	0	BA-P-284-204	2	7.47	319.60	2.316	9.2	1.6	27.55	0.00	4.00	R
462	C	GU	0	BA-P-302-115	1	8.36	524.90	1.577	9.1	1.7	61.16	0.00	2.50	U
463	C	GU	0	BA-P-312-309	3	7.71	281.40	3.139	9.8	2.5	41.49	0.00	3.75	U
464	C	GU	0	BA-P-315-301	3	7.68	1514.20	4.000	10.0	2.3	22.70	1.66	3.50	U
465	C	GU	0	BA-P-322-203	2	7.56	495.30	4.622	10.2	1.5	26.37	0.58	3.75	U

Classification of Non-Coastal Plain streams as degraded, reference, and unclassified.

Sampling Year=96
(continued)

OBS	REGION	BASIN	COASTAL	SITE	ORDER	PH_FLD	ANC	NO3	DO	DOC	FOREST	URBAN	FISHIBI	CLASS
466	C	GU	0	BA-P-333-303	3	7.63	281.70	3.376	10.6	1.7	39.50	3.00	4.00	R
467	C	GU	0	BA-P-340-214	2	7.26	359.00	1.346	10.2	5.1	13.13	0.00	3.50	U
468	C	GU	0	BA-P-341-212	2	7.74	576.60	3.730	10.4	3.6	23.52	0.89	4.25	U
469	C	GU	0	BA-P-379-307	3	7.62	437.40	2.962	9.8	1.2	33.26	0.39	4.25	R
470	C	GU	0	BA-P-379-315	3	8.07	452.80	2.905	9.7	1.2	33.34	0.39	4.25	R
471	C	GU	0	BA-P-403-106	1	7.35	1722.20	2.409	10.8	3.1	55.94	0.00	3.00	U
472	C	GU	0	BA-P-418-207	2	7.30	351.70	6.812	9.8	1.7	7.19	0.00	3.50	U
473	C	GU	0	BA-P-419-317	3	7.98	1612.30	2.284	9.4	1.1	45.81	1.07	3.75	U
474	C	GU	0	BA-P-427-107	1	7.02	398.50	4.851	10.3	2.8	33.97	0.00	.	
475	C	GU	0	BA-P-458-108	1	7.00	144.50	2.636	9.9	2.0	38.46	0.00	.	
476	C	GU	0	CR-P-047-316	3	7.46	499.90	3.011	11.1	1.0	29.91	0.45	4.75	R
477	C	GU	0	CR-P-070-314	3	7.74	528.80	3.222	9.6	1.3	30.09	0.57	4.50	R
478	C	GU	0	CR-P-171-306	3	7.42	518.00	3.296	9.7	1.3	28.11	0.51	4.25	R
479	C	GU	0	CR-P-403-112	1	6.99	243.10	5.060	10.6	0.6	17.68	0.00	.	
480	C	GU	0	HA-P-116-109	1	7.47	488.20	2.063	9.8	2.4	51.37	5.28	3.00	U
481	C	GU	0	HA-P-246-304	3	7.24	456.80	2.596	9.7	1.5	33.26	0.42	3.75	U
491	C	PP	0	BA-P-002-303	3	7.87	1314.20	1.687	9.7	2.5	57.19	8.10	3.50	U
492	C	PP	0	BA-P-013-328	3	7.77	3311.20	2.127	6.2	1.8	6.06	82.02	2.00	D
493	C	PP	0	BA-P-074-106	1	7.11	1124.60	2.000	8.7	3.0	23.89	72.27	1.25	D
494	C	PP	0	BA-P-077-315	3	7.37	795.00	1.319	8.3	2.6	56.52	4.12	3.25	U
495	C	PP	0	BA-P-125-126	1	7.63	1576.40	1.603	8.4	2.7	19.82	66.57	3.00	U
496	C	PP	0	BA-P-144-322	3	7.20	1001.60	0.332	8.9	3.2	32.95	25.26	3.25	U
497	C	PP	0	BA-P-145-316	3	7.55	1021.10	2.028	8.5	1.8	33.76	21.61	2.75	U
498	C	PP	0	BA-P-145-327	3	7.56	1007.50	2.126	8.9	1.8	33.67	21.65	3.75	U
499	C	PP	0	BA-P-262-111	1	7.64	2334.40	1.991	7.0	3.2	27.03	66.22	.	
500	C	PP	0	BA-P-269-214	2	8.16	2038.70	3.198	8.2	2.2	26.62	52.47	1.00	D
501	C	PP	0	BA-P-409-102	1	7.22	162.10	5.891	9.1	1.3	10.39	3.90	.	
502	C	PP	0	BA-P-410-203	2	7.50	943.70	2.264	9.6	1.3	20.08	28.44	3.25	U
503	C	PP	0	BA-P-478-314	3	7.78	1186.60	2.038	7.7	1.9	31.14	31.80	2.50	U
507	C	PP	0	BC-P-001-326	3	8.29	1193.30	0.304	8.7	2.1	29.00	41.49	2.25	U
508	C	PP	0	BC-P-003-228	2	7.34	1450.00	1.352	6.6	7.4	10.01	80.02	1.75	D
509	C	PP	0	BC-P-004-107	1	6.76	1152.10	2.416	0.9	2.5	10.66	86.86	1.00	U
510	C	PP	0	BC-P-005-306	3	7.86	2823.20	0.334	8.1	3.2	14.53	74.89	2.25	U
511	C	PP	0	BC-P-005-318	3	8.10	2905.60	0.335	8.7	3.0	10.47	78.29	1.50	D
512	C	PP	0	CR-P-020-208	2	6.90	517.40	2.582	8.9	1.6	24.73	6.60	4.50	U
513	C	PP	0	CR-P-026-109	1	6.74	226.80	4.614	10.4	1.0	17.34	1.71	4.75	U

Classification of Non-Coastal Plain streams as degraded, reference, and unclassified.

Sampling Year=96
(continued)

OBS	REGION	BASIN	COASTAL	SITE	ORDER	PH_FLD	ANC	NO3	DO	DOC	FOREST	URBAN	FISHIBI	CLASS
514	C	PP	0	CR-P-079-209	2	7.58	303.60	4.046	8.3	1.4	14.78	0.66	4.75	U
515	C	PP	0	CR-P-084-309	3	7.36	392.20	4.382	9.3	1.0	20.37	0.65	4.50	U
516	C	PP	0	CR-P-086-313	3	7.17	273.20	3.858	9.2	0.9	23.67	0.76	4.75	U
517	C	PP	0	CR-P-086-325	3	7.07	262.70	4.111	9.6	1.0	23.57	0.80	5.00	U
518	C	PP	0	CR-P-120-232	2	7.16	431.90	3.897	9.8	1.4	25.16	4.99	5.00	R
519	C	PP	0	CR-P-149-118	1	6.78	353.70	4.913	8.9	1.2	21.78	6.49	4.25	U
520	C	PP	0	CR-P-193-311	3	7.34	387.60	4.451	8.8	1.1	24.01	4.61	4.50	U
521	C	PP	0	CR-P-215-127	1	7.35	355.70	4.755	10.3	1.2	26.25	0.00	4.00	U
522	C	PP	0	CR-P-234-216	2	6.86	367.00	4.708	9.2	1.2	15.74	1.85	4.25	U
523	C	PP	0	CR-P-242-224	2	7.41	389.50	5.743	9.1	1.2	19.49	1.63	4.75	U
524	C	PP	0	CR-P-260-210	2	7.26	568.30	5.615	8.6	1.5	15.59	11.70	4.75	U
525	C	PP	0	CR-P-330-201	2	7.25	407.20	6.403	9.2	1.2	13.69	2.79	4.50	U
526	C	PP	0	CR-P-330-229	2	7.84	419.50	6.496	10.2	1.2	12.68	3.01	4.50	U
527	C	PP	0	CR-P-341-121	1	6.85	438.10	4.439	9.5	1.1	17.72	5.25	3.75	U
528	C	PP	0	CR-P-344-219	2	7.07	332.20	5.833	10.4	1.0	16.87	0.42	4.25	U
529	C	PP	0	CR-P-345-321	3	7.72	352.00	4.024	9.0	1.1	28.80	0.70	4.75	R
530	C	PP	0	CR-P-362-310	3	7.03	567.10	2.166	7.9	2.4	26.17	3.66	4.50	R
531	C	PP	0	CR-P-363-212	2	7.09	456.00	1.848	7.9	2.8	20.48	3.33	4.50	U
532	C	PP	0	CR-P-363-230	2	7.14	438.20	1.840	7.8	3.1	21.05	1.62	4.50	U
533	C	PP	0	CR-P-376-104	1	7.36	1282.70	3.256	9.1	1.3	12.28	8.71	3.50	U
534	C	PP	0	CR-P-376-119	1	7.31	1321.80	3.082	9.6	1.4	10.11	9.01	3.25	U
535	C	PP	0	CR-P-379-123	1	6.26	202.90	9.010	9.5	0.7	8.51	0.00	.	
536	C	PP	0	CR-P-409-320	3	7.39	518.30	5.439	9.6	1.0	22.29	3.19	3.75	U
537	C	PP	0	CR-P-415-103	1	6.40	118.80	3.366	9.4	0.9	9.40	0.00	.	
538	C	PP	0	CR-P-419-227	2	7.20	297.90	4.488	9.6	1.7	23.37	0.96	4.75	U
539	C	PP	0	CR-P-999-323	3	7.16	366.70	4.919	9.4	1.0	22.91	4.52	4.75	U
541	C	PP	0	HO-P-068-231	2	7.46	709.60	1.416	9.9	2.2	51.29	1.85	4.00	R
542	C	PP	0	HO-P-094-116	1	6.60	228.60	3.533	9.5	1.2	12.68	1.72	4.00	U
543	C	PP	0	HO-P-115-204	2	6.88	284.40	2.955	7.9	3.5	15.79	2.14	4.50	U
544	C	PP	0	HO-P-151-222	2	7.24	488.30	4.061	8.9	2.0	28.92	7.03	5.00	R
545	C	PP	0	HO-P-154-125	1	6.92	423.10	2.051	8.9	2.2	36.08	9.02	3.00	U
546	C	PP	0	HO-P-182-207	2	7.33	979.20	2.206	9.5	2.0	60.00	0.00	4.25	R
569	E	EL	0	CE-P-004-102	1	7.21	217.40	0.607	9.0	2.8	41.44	5.77	4.25	R
570	E	EL	0	CE-P-009-303	3	6.86	403.40	3.076	9.7	3.9	28.47	2.14	4.25	R
571	E	EL	0	CE-P-009-305	3	7.48	396.50	2.496	9.5	4.7	29.37	2.08	4.25	R
572	E	EL	0	CE-P-012-210	2	8.06	420.50	4.030	10.5	2.5	18.29	0.10	4.00	U

Classification of Non-Coastal Plain streams as degraded, reference, and unclassified.

Sampling Year=96
(continued)

OBS	REGION	BASIN	COASTAL	SITE	ORDER	PH_FLD	ANC	NO3	DO	DOC	FOREST	URBAN	FISHIBI	CLASS
573	E	EL	0	CE-P-012-212	2	7.58	408.50	4.260	9.7	2.9	18.22	0.10	4.00	U
574	E	EL	0	CE-P-020-118	1	6.65	138.90	0.565	7.1	4.1	61.46	5.49	3.25	U
575	E	EL	0	CE-P-038-205	2	7.29	753.80	3.468	9.2	3.2	19.62	0.68	4.00	U
576	E	EL	0	CE-P-038-209	2	7.07	693.60	3.258	8.4	3.0	19.60	0.64	4.00	U
577	E	EL	0	CE-P-046-207	2	7.47	646.10	3.071	9.2	4.5	22.13	2.04	3.50	U
578	E	EL	0	CE-P-046-214	2	7.75	589.40	2.448	8.9	6.5	22.27	2.03	3.50	U
579	E	EL	0	CE-P-081-106	1	7.26	631.80	2.884	9.8	4.5	26.68	3.53	4.00	R
580	E	EL	0	CE-P-081-114	1	7.87	530.70	2.415	9.6	4.8	31.91	4.24	4.25	R
581	E	EL	0	CE-P-085-109	1	7.07	616.60	0.759	10.2	7.6	41.94	1.38	.	
582	E	EL	0	CE-P-999-105	1	6.86	185.40	0.885	9.3	6.7	39.95	2.26	3.50	U
583	W	MP	0	CR-P-013-108	1	7.10	180.30	3.197	12.2	1.0	41.35	0.00	.	
584	W	MP	0	CR-P-019-201	2	7.07	602.40	5.341	8.5	1.0	18.96	0.57	4.25	U
585	W	MP	0	CR-P-019-248	2	6.95	801.70	5.193	8.7	2.7	17.37	0.04	1.75	D
586	W	MP	0	CR-P-021-329	3	7.90	1560.90	5.358	9.6	1.6	21.04	0.11	3.00	U
587	W	MP	0	CR-P-035-216	2	8.14	735.90	3.246	9.4	3.0	22.07	0.52	5.00	U
588	W	MP	0	CR-P-094-349	3	7.47	2517.70	5.557	9.4	0.8	17.83	8.31	5.00	U
589	W	MP	0	CR-P-116-316	3	7.78	889.70	4.030	9.6	3.1	13.41	2.55	3.75	U
590	W	MP	0	CR-P-116-327	3	7.25	895.50	4.019	7.5	2.6	13.47	2.54	4.00	U
591	W	MP	0	CR-P-142-324	3	8.61	762.50	2.981	10.7	6.6	13.79	1.93	4.50	U
592	W	MP	0	CR-P-156-314	3	7.23	604.70	4.571	9.3	1.8	12.26	3.18	5.00	U
593	W	MP	0	CR-P-156-361	3	7.43	605.00	4.602	9.3	1.7	12.27	3.19	5.00	U
594	W	MP	0	CR-P-158-123	1	7.63	2713.50	23.729	8.1	2.3	4.21	0.00	.	
595	W	MP	0	CR-P-162-207	2	7.58	1342.30	8.098	9.1	1.7	13.69	1.67	3.50	U
596	W	MP	0	CR-P-180-124	1	7.17	536.30	2.134	8.0	3.5	17.32	0.14	4.25	U
597	W	MP	0	CR-P-205-319	3	8.10	564.10	3.478	10.4	1.2	23.95	0.71	4.50	U
598	W	MP	0	CR-P-243-333	3	7.73	647.10	3.613	9.1	2.2	23.69	0.82	4.75	U
599	W	MP	0	CR-P-249-103	1	7.09	402.40	4.435	9.0	2.0	12.18	0.00	.	
600	W	MP	0	CR-P-249-113	1	6.37	567.20	6.414	5.9	2.2	11.76	0.00	.	
601	W	MP	0	CR-P-263-332	3	8.11	2022.90	6.901	12.4	2.8	18.39	9.19	3.50	U
602	W	MP	0	CR-P-274-104	1	7.28	1739.20	10.253	9.0	1.0	7.44	0.00	1.50	D
603	W	MP	0	CR-P-280-340	3	7.33	628.70	3.521	8.5	2.1	24.75	0.86	4.75	U
604	W	MP	0	CR-P-284-328	3	7.85	558.30	3.534	7.5	1.3	23.80	0.84	5.00	U
605	W	MP	0	CR-P-295-128	1	7.72	2411.50	4.012	5.9	1.5	5.15	18.56	.	
606	W	MP	0	CR-P-318-338	3	7.62	673.80	4.666	7.9	1.8	17.74	0.47	4.75	U
607	W	MP	0	CR-P-323-326	3	8.55	563.90	3.536	10.7	1.4	24.20	0.73	4.50	U
608	W	MP	0	CR-P-365-219	2	7.76	1078.70	5.013	8.5	1.1	17.91	1.33	5.00	U

Classification of Non-Coastal Plain streams as degraded, reference, and unclassified.

Sampling Year=96
(continued)

OBS	REGION	BASIN	COASTAL	SITE	ORDER	PH_FLD	ANC	NO3	DO	DOC	FOREST	URBAN	FISHIBI	CLASS
609	W	MP	0	CR-P-374-343	3	7.49	634.10	4.825	9.9	1.8	17.00	0.38	4.75	U
610	W	MP	0	CR-P-400-144	1	6.65	1382.90	2.649	6.7	4.7	8.77	5.26	.	
611	W	MP	0	CR-P-406-102	1	7.23	848.00	5.536	7.1	3.0	9.48	0.00	4.00	U
612	W	MP	0	CR-P-434-138	1	7.40	717.10	5.795	7.7	2.1	20.51	0.00	.	
613	W	MP	0	FR-B-032-206	2	7.29	675.90	1.814	8.5	1.2	69.62	0.54	3.75	U
614	W	MP	0	FR-B-046-127	1	7.05	360.20	0.403	8.2	0.7	99.34	0.00	1.00	D
615	W	MP	0	FR-B-065-111	1	7.25	831.30	10.304	7.8	1.2	4.66	8.24	.	
616	W	MP	0	FR-B-076-118	1	6.93	624.00	3.319	5.5	1.9	12.38	4.76	.	
617	W	MP	0	FR-B-081-229	2	8.39	284.00	1.113	9.5	1.3	78.20	0.00	2.75	U
618	W	MP	0	FR-B-133-222	2	7.24	324.90	1.347	9.8	1.3	82.59	0.00	4.25	R
619	W	MP	0	FR-B-164-137	1	7.75	274.00	0.734	8.1	2.0	90.94	0.00	3.75	U
620	W	MP	0	FR-P-005-141	1	6.90	790.30	1.129	11.5	1.6	69.87	3.99	1.25	D
621	W	MP	0	FR-P-009-341	3	7.52	1080.00	0.430	8.6	4.2	33.01	1.51	4.75	R
622	W	MP	0	FR-P-009-347	3	7.94	1051.90	0.397	9.6	3.8	34.18	0.56	4.75	R
623	W	MP	0	FR-P-015-304	3	7.35	445.80	3.713	9.3	1.4	25.16	1.71	4.75	R
624	W	MP	0	FR-P-034-228	2	6.87	131.90	0.428	8.7	1.2	98.24	0.12	4.00	R
625	W	MP	0	FR-P-038-139	1	7.20	312.60	0.572	9.3	1.3	98.47	0.00	1.75	D
626	W	MP	0	FR-P-046-227	2	7.42	2667.00	7.706	8.6	2.0	10.17	0.10	3.25	U
627	W	MP	0	FR-P-050-354	3	6.78	1070.30	2.280	8.6	2.1	38.15	0.40	3.50	U
628	W	MP	0	FR-P-093-237	2	7.04	1109.10	0.960	9.5	5.8	89.31	0.05	2.75	U
629	W	MP	0	FR-P-093-238	2	7.04	1104.20	0.954	9.5	5.9	89.15	0.05	2.50	U
630	W	MP	0	FR-P-100-117	1	7.11	440.10	2.389	8.8	1.2	58.72	0.46	3.50	U
631	W	MP	0	FR-P-101-233	2	7.34	516.40	4.275	9.9	2.8	14.74	2.03	4.75	U
632	W	MP	0	FR-P-103-230	2	7.34	1051.20	4.543	10.1	1.8	30.72	4.20	4.25	U
633	W	MP	0	FR-P-111-134	1	7.31	526.60	7.959	8.6	3.6	5.08	0.00	3.25	U
634	W	MP	0	FR-P-116-221	2	7.62	345.60	2.708	9.9	1.8	43.55	0.19	4.50	R
635	W	MP	0	FR-P-132-320	3	6.92	311.20	0.514	9.5	1.9	83.37	0.24	4.50	R
636	W	MP	0	FR-P-156-217	2	7.57	271.10	3.102	9.9	1.1	32.44	0.25	4.50	R
637	W	MP	0	FR-P-156-231	2	7.47	265.60	3.042	10.1	1.3	33.54	0.22	5.00	R
638	W	MP	0	FR-P-156-234	2	6.92	274.30	3.014	9.2	0.9	34.43	0.18	4.75	R
639	W	MP	0	FR-P-156-252	2	7.38	271.10	2.616	10.0	2.0	31.90	0.24	5.00	R
640	W	MP	0	FR-P-168-218	2	7.67	1662.70	5.507	9.0	3.2	17.09	7.97	3.00	U
641	W	MP	0	FR-P-214-303	3	6.71	554.70	1.377	7.6	1.7	53.26	0.40	4.75	R
642	W	MP	0	FR-P-214-342	3	6.33	556.70	1.378	8.7	1.7	52.75	0.39	4.50	R
643	W	MP	0	FR-P-223-225	2	7.82	1831.30	4.708	9.7	2.9	16.73	0.15	3.50	U
644	W	MP	0	FR-P-223-240	2	7.36	1440.20	5.442	9.2	1.6	15.43	0.17	2.75	U

Classification of Non-Coastal Plain streams as degraded, reference, and unclassified.

Sampling Year=96
(continued)

OBS	REGION	BASIN	COASTAL	SITE	ORDER	PH_FLD	ANC	NO3	DO	DOC	FOREST	URBAN	FISHIBI	CLASS
645	W	MP	0	FR-P-258-202	2	6.58	514.80	0.937	8.1	5.0	21.93	0.51	4.25	U
646	W	MP	0	FR-P-258-215	2	6.49	436.50	0.808	8.9	4.0	22.18	0.58	4.50	U
647	W	MP	0	FR-P-258-243	2	6.74	237.80	0.725	7.6	1.9	22.02	0.52	4.25	U
648	W	MP	0	FR-P-261-122	1	7.25	353.10	3.589	8.1	2.2	15.02	2.92	4.25	U
649	W	MP	0	FR-P-263-311	3	6.85	1892.60	5.454	9.3	2.0	25.51	2.95	4.00	U
650	W	MP	0	FR-P-265-335	3	7.93	1034.30	0.944	9.0	2.7	56.05	0.93	4.50	R
651	W	MP	0	FR-P-265-351	3	8.24	1041.80	0.989	9.3	2.5	56.04	0.94	4.75	R
652	W	MP	0	FR-P-275-239	2	7.30	315.30	3.377	9.6	1.1	29.50	4.57	4.50	R
653	W	MP	0	FR-P-277-115	1	7.15	743.30	4.087	7.5	2.0	40.87	1.81	3.50	U
654	W	MP	0	FR-P-288-133	1	8.17	292.80	0.559	8.7	1.7	88.62	4.34	5.00	R
655	W	MP	0	FR-P-290-121	1	6.83	1899.90	4.573	7.6	1.5	41.40	2.71	1.50	D
656	W	MP	0	FR-P-294-313	3	7.74	461.10	0.946	7.8	1.9	63.97	4.56	4.00	R
657	W	MP	0	FR-P-294-357	3	7.27	583.10	0.803	7.6	1.1	64.90	4.63	4.50	R
658	W	MP	0	FR-P-298-308	3	6.66	517.30	1.453	7.6	1.6	59.13	0.24	4.25	R
659	W	MP	0	FR-P-300-130	1	7.00	770.40	5.981	5.2	5.2	4.20	0.12	1.50	D
660	W	MP	0	FR-P-302-334	3	6.48	370.20	1.016	8.6	1.5	80.80	0.23	4.75	R
661	W	MP	0	FR-P-319-352	3	6.19	551.20	1.269	9.3	1.4	66.11	0.24	4.50	R
662	W	MP	0	FR-P-321-214	2	7.80	438.10	4.075	8.6	1.0	25.21	2.42	4.75	R
663	W	MP	0	FR-P-335-110	1	7.57	4148.30	2.789	5.8	1.9	4.98	21.71	3.00	U
664	W	MP	0	FR-P-349-204	2	8.75	1592.00	4.158	9.2	1.4	41.70	3.51	4.25	R
665	W	MP	0	FR-P-351-112	1	6.91	467.50	3.540	7.5	1.9	1.74	0.00	.	
666	W	MP	0	FR-P-354-321	3	7.10	2151.40	6.134	7.8	2.2	22.36	2.39	3.50	U
667	W	MP	0	FR-P-360-220	2	7.16	880.50	5.542	7.6	2.3	12.20	2.49	3.50	U
668	W	MP	0	FR-P-371-132	1	7.26	1087.10	2.704	6.3	3.9	5.94	0.00	3.00	U
669	W	MP	0	FR-P-377-242	2	8.30	264.30	3.026	9.2	1.7	33.38	1.49	4.50	R
670	W	MP	0	FR-P-388-208	2	7.40	301.60	2.829	10.2	0.8	39.10	1.12	4.50	R
671	W	MP	0	FR-P-388-246	2	6.79	303.30	3.117	8.5	0.9	39.95	1.24	4.50	R
672	W	MP	0	FR-P-394-317	3	7.36	976.70	2.270	8.5	1.5	39.29	0.44	4.00	R
673	W	MP	0	FR-P-399-126	1	6.73	511.60	7.096	9.9	1.7	26.32	0.00	.	
674	W	MP	0	FR-P-409-210	2	7.81	1519.40	3.849	11.6	2.9	35.86	0.13	2.25	U
675	W	MP	0	FR-P-411-305	3	7.35	1141.00	3.681	8.9	1.2	29.84	0.80	4.75	R
676	W	MP	0	FR-P-421-306	3	6.99	739.00	2.932	8.3	1.9	31.07	3.56	4.50	R
677	W	MP	0	FR-P-429-307	3	7.56	1825.90	4.565	9.6	1.8	32.25	4.80	5.00	U
678	W	MP	0	FR-P-461-251	2	8.07	631.00	2.492	9.4	2.6	36.12	1.04	4.25	R
679	W	MP	0	FR-P-462-346	3	7.39	1902.80	6.157	11.5	1.4	14.33	0.09	2.00	D
680	W	MP	0	FR-P-474-302	3	7.51	1948.70	5.432	9.0	2.1	18.99	0.43	2.50	U

Classification of Non-Coastal Plain streams as degraded, reference, and unclassified.

Sampling Year=96
(continued)

OBS	REGION	BASIN	COASTAL	SITE	ORDER	PH_FLD	ANC	NO3	DO	DOC	FOREST	URBAN	FISHIBI	CLASS
681	W	MP	0	FR-P-479-348	3	7.88	388.90	1.238	8.4	1.6	86.36	0.15	4.75	R
682	W	MP	0	FR-P-516-235	2	6.87	1561.20	1.850	7.5	1.7	34.31	1.18	4.00	R
683	W	MP	0	FR-P-545-325	3	7.26	690.10	2.891	9.6	1.6	32.79	5.35	4.75	R
684	W	MP	0	FR-P-545-345	3	7.08	688.50	2.917	9.3	1.4	32.80	5.37	4.75	R
685	W	MP	0	MO-P-111-136	1	7.23	100.20	0.846	7.7	1.2	61.54	0.00	.	
686	W	MP	0	MO-P-248-125	1	7.19	293.20	2.264	9.2	0.9	54.89	3.95	4.75	R
687	W	MP	0	MO-P-495-312	3	7.12	454.90	2.605	9.7	1.2	48.38	1.75	5.00	R
688	W	MP	0	WA-B-018-209	2	7.16	489.30	2.406	7.9	1.6	62.80	0.33	4.00	R
689	W	MP	0	WA-B-018-241	2	7.05	506.00	2.406	9.5	1.7	61.69	0.34	3.75	U
690	W	NO	0	AL-A-007-304	3	7.44	515.90	1.177	7.7	1.2	80.35	0.45	3.00	U
691	W	NO	0	AL-A-054-320	3	6.97	654.80	0.859	8.1	1.1	82.21	3.34	2.50	U
692	W	NO	0	AL-A-187-218	2	6.43	391.60	0.789	7.5	2.0	99.13	0.00	1.50	D
693	W	NO	0	AL-A-202-121	1	7.39	343.10	1.113	8.2	1.1	91.95	0.00	2.50	U
694	W	NO	0	AL-A-221-107	1	3.95	-3.40	1.211	9.3	1.0	81.00	0.08	1.00	U
695	W	NO	0	AL-A-229-109	1	4.72	-10.50	0.307	8.1	1.1	98.44	0.00	1.00	U
696	W	NO	0	AL-A-232-313	3	7.21	175.70	0.795	7.4	2.4	81.50	5.41	1.50	D
697	W	NO	0	AL-A-254-326	3	7.73	308.70	0.594	10.1	0.8	83.75	4.04	2.00	D
698	W	NO	0	AL-A-268-221	2	6.90	475.20	0.303	6.0	3.3	92.56	0.00	1.50	D
699	W	NO	0	AL-A-276-323	3	7.64	922.30	0.689	8.7	2.7	79.50	0.17	5.00	R
700	W	NO	0	AL-A-294-325	3	6.80	327.80	0.328	8.1	2.9	89.38	0.02	4.25	R
701	W	NO	0	AL-A-296-226	2	4.76	-92.20	0.618	9.0	1.4	92.67	0.00	1.00	U
702	W	NO	0	AL-A-343-307	3	6.71	518.00	0.860	8.7	1.0	82.33	2.97	1.75	D
703	W	NO	0	AL-A-343-330	3	6.71	678.30	0.673	8.7	1.9	82.35	2.96	2.25	U
704	W	NO	0	AL-A-380-303	3	7.13	395.80	0.261	8.7	2.2	91.56	0.00	3.00	U
705	W	NO	0	AL-A-413-308	3	7.69	1483.70	0.711	9.4	1.3	83.39	3.93	2.25	U
706	W	NO	0	AL-A-425-314	3	7.46	3922.10	1.036	8.1	1.4	84.62	2.76	4.75	R
707	W	NO	0	AL-A-465-311	3	7.21	560.90	0.256	8.6	1.5	89.01	0.03	3.50	U
708	W	NO	0	AL-A-465-324	3	6.96	282.70	0.304	7.8	2.1	89.16	0.04	3.25	U
709	W	NO	0	AL-A-480-205	2	6.75	232.50	0.455	8.9	1.2	80.54	0.00	1.50	D
710	W	NO	0	AL-A-485-220	2	7.56	140.60	0.676	7.9	1.7	96.88	0.50	1.00	D
711	W	NO	0	AL-A-485-227	2	7.62	446.60	0.738	7.2	2.1	82.38	10.85	1.50	D
712	W	NO	0	AL-A-550-204	2	7.32	338.80	0.366	8.3	2.3	87.49	0.00	4.00	R
713	W	NO	0	AL-A-567-126	1	4.85	-12.70	0.616	7.5	1.6	86.96	0.62	.	
714	W	NO	0	AL-A-585-122	1	8.19	3503.90	2.456	8.2	2.3	45.17	1.31	2.75	U
715	W	NO	0	AL-A-626-216	2	7.72	629.40	0.676	8.5	1.1	100.6	0.00	2.00	D
716	W	NO	0	AL-A-706-228	2	6.79	30.60	0.269	7.5	2.4	97.82	0.00	2.00	D

Classification of Non-Coastal Plain streams as degraded, reference, and unclassified.

Sampling Year=96
(continued)

OBS	REGION	BASIN	COASTAL	SITE	ORDER	PH_FLD	ANC	NO3	DO	DOC	FOREST	URBAN	FISHIBI	CLASS
717	W	NO	0	AL-A-726-115	1	6.57	85.60	1.324	7.7	0.8	100.8	0.00	.	
718	W	NO	0	AL-A-999-117	1	7.90	2622.00	2.755	8.9	1.7	98.18	0.00	1.00	D
719	W	NO	0	GA-A-002-312	3	5.96	135.20	0.579	8.9	2.1	66.74	0.46	4.00	U
720	W	NO	0	GA-A-008-213	2	7.28	76.10	1.196	8.5	1.0	81.78	0.14	4.00	R
721	W	NO	0	GA-A-017-223	2	6.78	132.00	0.363	7.3	1.0	78.27	0.00	1.50	D
722	W	NO	0	GA-A-022-215	2	6.51	245.40	0.837	7.4	1.0	47.38	0.00	4.75	R
723	W	NO	0	GA-A-053-206	2	6.72	111.40	0.465	8.1	0.9	93.40	0.05	3.50	U
724	W	NO	0	GA-A-076-209	2	6.63	98.80	0.795	9.4	0.7	86.07	0.08	4.50	R
725	W	NO	0	GA-A-090-310	3	7.06	73.60	0.504	8.5	0.9	97.36	0.00	4.00	R
726	W	NO	0	GA-A-105-317	3	6.89	158.60	0.739	7.9	2.9	66.33	0.52	4.50	R
727	W	NO	0	GA-A-105-318	3	7.25	160.40	0.773	7.6	2.6	66.82	0.52	4.25	R
728	W	NO	0	GA-A-121-210	2	6.74	63.60	0.572	8.3	1.1	80.26	0.00	3.50	U
729	W	NO	0	GA-A-133-112	1	7.47	149.00	0.677	9.1	1.1	81.82	0.00	2.00	D
730	W	NO	0	GA-A-159-202	2	6.88	66.30	0.716	8.5	1.0	90.35	0.03	4.50	R
731	W	NO	0	GA-A-184-328	3	6.95	140.60	0.631	7.7	1.4	81.98	0.19	4.50	R
732	W	NO	0	GA-A-191-322	3	7.19	233.40	0.403	7.8	1.3	81.20	0.00	3.25	U
733	W	NO	0	GA-A-205-222	2	3.36	-319.70	0.497	9.3	0.8	92.96	0.03	1.00	U
734	W	NO	0	GA-A-276-106	1	6.79	55.20	0.494	9.0	0.8	92.12	0.00	3.50	U
735	W	NO	0	GA-A-314-116	1	6.77	140.20	0.417	7.2	1.2	70.37	0.00	.	
736	W	NO	0	GA-A-315-101	1	6.58	84.40	1.853	7.9	1.1	60.85	0.00	3.00	U
737	W	NO	0	GA-A-372-129	1	6.63	89.60	0.735	7.4	1.6	97.41	0.00	.	
738	W	NO	0	GA-A-416-118	1	6.61	61.10	0.828	8.4	0.6	91.89	0.00	.	
739	W	NO	0	GA-A-470-306	3	7.15	187.90	0.345	8.4	1.1	86.55	0.06	2.25	U
740	W	NO	0	GA-A-470-309	3	7.00	185.10	0.352	8.2	1.0	86.60	0.06	2.25	U
741	W	NO	0	GA-A-470-315	3	6.98	177.80	0.355	8.2	1.1	86.61	0.06	2.75	U
742	W	NO	0	GA-A-496-105	1	7.87	861.50	0.322	7.7	1.6	24.84	0.00	3.25	U
743	W	NO	0	GA-A-512-214	2	6.79	65.40	0.535	7.6	0.9	73.17	0.00	3.25	U
744	W	NO	0	GA-A-523-203	2	6.95	466.10	0.530	8.9	1.1	86.84	0.00	2.00	D
745	W	NO	0	GA-A-558-211	2	6.82	183.20	0.764	7.2	3.6	65.44	0.98	4.00	R
746	W	NO	0	GA-A-999-302	3	6.76	88.40	0.801	7.8	1.5	82.69	0.17	4.25	R

APPENDIX B

Summary of Principal Components Analysis (PCA), stepwise discriminate analysis and stepwise logistic regression for MPHI development in both Coastal and Non-Coastal Plain strata. Validation results from the redundancy and no redundancy index when applied to 1997 MBSS data for both strata is included on the last two pages of this appendix.

Correlation matrix for continuous metrics at Coastal Plain sites.

	INSTRHAB	EPI_SUB	VEL_DPTH	RIFFQUAL	EMBEDDED
INSTRHAB	1.0000	0.8659	0.8117	0.7577	-.7499
EPI_SUB	0.8659	1.0000	0.7293	0.7341	-.8342
VEL_DPTH	0.8117	0.7293	1.0000	0.7819	-.7802
RIFFQUAL	0.7577	0.7341	0.7819	1.0000	-.7262
EMBEDDED	-.7499	-.8342	-.7802	-.7262	1.0000
MAXDEPTH	0.6633	0.5496	0.7767	0.4979	-.6059
POOLQUAL	0.8172	0.6304	0.8021	0.5893	-.5705
REMOTE	0.1026	-.0041	0.1485	0.1294	-.0541
AESTHET	0.0108	-.0140	0.0819	0.1175	-.0096
CHAN_ALT	0.5786	0.5909	0.4753	0.5261	-.5224

	MAXDEPTH	POOLQUAL	REMOTE	AESTHET	CHAN_ALT
INSTRHAB	0.6633	0.8172	0.1026	0.0108	0.5786
EPI_SUB	0.5496	0.6304	-.0041	-.0140	0.5909
VEL_DPTH	0.7767	0.8021	0.1485	0.0819	0.4753
RIFFQUAL	0.4979	0.5893	0.1294	0.1175	0.5261
EMBEDDED	-.6059	-.5705	-.0541	-.0096	-.5224
MAXDEPTH	1.0000	0.8329	0.1572	0.0209	0.3699
POOLQUAL	0.8329	1.0000	0.2620	0.1178	0.4711
REMOTE	0.1572	0.2620	1.0000	0.7780	0.2240
AESTHET	0.0209	0.1178	0.7780	1.0000	0.2190
CHAN_ALT	0.3699	0.4711	0.2240	0.2190	1.0000

Eigenvalues of the correlation matrix from PCA analysis at Coastal Plain sites.

	Eigenvalue	Difference	Proportion	Cumulative
PC_CON1	5.75184	3.93877	0.575184	0.57518
PC_CON2	1.81307	0.97242	0.181307	0.75649
PC_CON3	0.84065	0.32333	0.084065	0.84056
PC_CON4	0.51732	0.20317	0.051732	0.89229
PC_CON5	0.31415	0.02888	0.031415	0.92370
PC_CON6	0.28527	0.07825	0.028527	0.95223
PC_CON7	0.20701	0.08594	0.020701	0.97293
PC_CON8	0.12107	0.03688	0.012107	0.98504
PC_CON9	0.08419	0.01875	0.008419	0.99346
PC_CON10	0.06544	.	0.006544	1.00000

Eigenvectors from PCA at Coastal Plain sites.

	PC_CON1	PC_CON2	PC_CON3	PC_CON4	PC_CON5
INSTRHAB	0.386672 *	-.081395	-.022050	0.040222	0.296613
EPI_SUB	0.365201 *	-.142054	-.283071	-.084718	-.151254
VEL_DPTH	0.383137 *	-.032858	0.182713	-.206317	0.038884
RIFFQUAL	0.348538 *	-.018421	-.250196	-.414593	0.513490
EMBEDDED	-.357371 *	0.111526	0.197028	0.295751	0.653673
MAXDEPTH	0.327999 *	-.023901	0.562183	0.196616	-.326486
POOLQUAL	0.356644 *	0.054322	0.429699	0.250032	0.287052
REMOTE	0.085744	0.681706 *	0.102481	-.053899	-.046523
AESTHET	0.052793	0.688625 *	-.110264	-.181350	-.069305
CHAN_ALT	0.276059	0.129957	-.511107	0.743179	-.026659

Correlation Matrix for continuous metrics at Non-Coastal Plain sites.

	NUMROOT	INSTRHAB	EPI_SUB	VEL_DPTH	RIFFQUAL
NUMROOT	1.0000	0.2617	0.1782	0.3622	0.2479
INSTRHAB	0.2617	1.0000	0.5195	0.7612	0.7011
EPI_SUB	0.1782	0.5195	1.0000	0.5136	0.6280
VEL_DPTH	0.3622	0.7612	0.5136	1.0000	0.7249
RIFFQUAL	0.2479	0.7011	0.6280	0.7249	1.0000
EMBEDDED	-.1375	-.2926	-.5406	-.3419	-.4828
MAXDEPTH	0.3437	0.6390	0.3466	0.8005	0.5393
POOLQUAL	0.3088	0.7089	0.3126	0.7641	0.5739
CH_FLOW	0.2148	0.4814	0.1502	0.4955	0.5143
SHADING	0.0663	-.0957	-.0240	-.1647	-.1544

	EMBEDDED	MAXDEPTH	POOLQUAL	CH_FLOW	SHADING
NUMROOT	-.1375	0.3437	0.3088	0.2148	0.0663
INSTRHAB	-.2926	0.6390	0.7089	0.4814	-.0957
EPI_SUB	-.5406	0.3466	0.3126	0.1502	-.0240
VEL_DPTH	-.3419	0.8005	0.7641	0.4955	-.1647
RIFFQUAL	-.4828	0.5393	0.5739	0.5143	-.1544
EMBEDDED	1.0000	-.2265	-.2162	-.0692	0.0089
MAXDEPTH	-.2265	1.0000	0.7598	0.4346	-.1734
POOLQUAL	-.2162	0.7598	1.0000	0.5306	-.2175
CH_FLOW	-.0692	0.4346	0.5306	1.0000	-.3201
SHADING	0.0089	-.1734	-.2175	-.3201	1.0000

Eigenvalues of the correlation matrix for Non-Coastal Plain Sites.

	Eigenvalue	Difference	Proportion	Cumulative
PC_CON1	4.85063	3.46533	0.485063	0.48506
PC_CON2	1.38530	0.32507	0.138530	0.62359
PC_CON3	1.06024	0.31781	0.106024	0.72962
PC_CON4	0.74243	0.14465	0.074243	0.80386
PC_CON5	0.59778	0.12502	0.059778	0.86364
PC_CON6	0.47276	0.18212	0.047276	0.91092
PC_CON7	0.29064	0.04060	0.029064	0.93998
PC_CON8	0.25005	0.04700	0.025005	0.96498
PC_CON9	0.20305	0.05594	0.020305	0.98529
PC_CON10	0.14711	.	0.014711	1.00000

Eigenvectors for Non-Coastal Plain sites.

	PC_CON1	PC_CON2	PC_CON3	PC_CON4	PC_CON5
NUMROOT	0.188055	-.018540	0.629428 *	-.726310	0.023150
INSTRHAB	0.387801 *	-.004870	0.038702	0.291130	0.088838
EPI_SUB	0.284042	-.484848 *	-.207216	-.026191	0.028748
VEL_DPTH	0.415650 *	0.034755	0.084011	0.115759	-.163056
RIFFQUAL	0.383457 *	-.158207	-.169857	0.014987	0.312829
EMBEDDED	-.209341	0.551616 *	0.270397	0.296367	0.099882
MAXDEPTH	0.370180 *	0.164278	0.178956	0.144297	-.434257
POOLQUAL	0.378513 *	0.228420	0.109896	0.173337	-.221514
CH_FLOW	0.281030	0.397534 *	-.109331	-.110417	0.713524
SHADING	-.103221	-.443668 *	0.627937	0.471713	0.330991

Stepwise Discriminant Selection for Coastal Plain sites.

Step	Variable Entered	Variable Removed	Number In	Partial R**2	F Statistic	Prob > F
1	INSTRHAB		1	0.3846	43.747	0.0001
2	AESTHET		2	0.2724	25.835	0.0001
3	MAXDEPTH		3	0.1340	10.521	0.0018
4	EMER_VEG		4	0.1091	8.203	0.0056
5	GRAVEL		5	0.0798	5.727	0.0196
6	SAND		6	0.0619	4.287	0.0424
7	RUN_GLID		7	0.0505	3.406	0.0696
8		RUN_GLID	6	0.0505	3.406	0.0696

Summary of the results for Coastal Plain Stream sites using a logistic stepwise regression procedure.

Step	Variable Entered	Variable Removed	Number In	Score Chi-Square	Wald Chi-Square	Pr > Chi-Square
1	INSTRHAB		1	27.6912	.	0.0001
2	AESTHET		2	21.3569	.	0.0001
3	MAXDEPTH		3	13.4301	.	0.0002
4	EMER_VEG		4	14.5526	.	0.0001
5		INSTRHAB	3	.	3.7488	0.0528
6	INSTRHAB		4	15.3066	.	0.0001
7		INSTRHAB	3	.	3.7488	0.0528

Summary of results for the stepwise discriminate analysis for the Non-Coastal Plain sites.

Step	Variable Entered	Removed	Number In	Partial R**2	F Statistic	Prob > F
1	VEL_DPTH		1	0.3486	91.524	0.0001
2	RUN_GLID		2	0.1297	25.346	0.0001
3	INSTRHAB		3	0.0621	11.189	0.0010
4	STORMDRN		4	0.0497	8.787	0.0035
5	EMBEDDED		5	0.0572	10.130	0.0017
6	UNDCTBNK		6	0.0272	4.633	0.0328
7	CH_FLOW		7	0.0189	3.187	0.0761
8		CH_FLOW	6	0.0189	3.187	0.0761

Summary of stepwise logistic regression procedure for Non-Coastal Plain sites.

Step	Variable Entered	Removed	Number In	Score Chi-Square	Wald Chi-Square	Pr > Chi-Square
1	VEL_DPTH		1	60.3132	.	0.0001
2	RUN_GLID		2	20.3502	.	0.0001
3	INSTRHAB		3	9.3163	.	0.0023
4	CH_FLOW		4	7.7038	.	0.0055
5	EMBEDDED		5	8.1743	.	0.0042
6		VEL_DPTH	4	.	3.3523	0.0671
7	STORMDRN		5	7.9294	.	0.0049
8	NUMROOT		6	5.4342	.	0.0197

Table of observed class by predicted class where the predicted class was obtained using the redundancy index for Coastal Plain sites. The 1997 MBSS data was used for validation.

Observed Class / Predicted Class

Frequency Row Pct	D	R	Total	
D	19 57.58	14 42.42	33	(19 + 13)/56 = .5715
R	10 43.48	13 56.52	23	
U	41 42.71	55 57.29	96	
Total	70	82	152	

Table of observed class by predicted class where the predicted class was obtained using the no redundancy index for Coastal Plain sites. The 1997 MBSS data was used for validation.

Observed Class / Predicted Class

Frequency Row Pct	D	R	Total	
D	25 75.76	8 24.24	33	(25 + 19)/56 = .7857
R	4 17.39	19 82.61	23	
U	31 32.29	65 67.71	96	
Total	60	92	152	

Table of observed class by predicted class where the predicted class was obtained using the redundancy index for Non-Coastal Plain sites. The 1997 MBSS data was used for validation.

Observed Class — Predicted Class

Frequency / Row Pct	D	R	Total	
D	12 80.00	3 20.00	15	(12 + 52)/76 = 0.842
R	9 14.75	52 85.25	61	
U	21 23.08	70 76.92	91	
Total	42	125	167	

Table of observed class by predicted class where the predicted class was obtained using the no redundancy index for Non-Coastal Plain sites. The 1997 MBSS data was used for validation.

Observed Class — Predicted Class

Frequency / Row Pct	D	R	Total	
D	9 60.00	6 40.00	15	(9 + 47)/76 = 0.737
R	14 22.95	47 77.05	61	
U	17 18.68	74 81.32	91	
Total	40	127	167	

APPENDIX C

For each categorical metric, a cross tabulation between each field crew and the QC officer is shown. Within each cell of the table, the number before the / is the frequency of occurrence as rated by the crew (0) or the QC officer (1). The number after the / is the total number of sites rated by both the crew and the QC officer. The last line of each table shows the p-value for a chi-square statistic comparing the crew and the QC officer. A p-value of <= 0.017 indicates a significant difference.

metric	QC	Crew: AL	DNR	WREC
BEAVPOND	0	0/18	1/37	0/13
	1	0/18	0/37	0/13
p-value		1.000	0.314	1.000

metric	QC	Crew: AL	DNR	WREC
BEDROCK	0	4/18	6/37	0/13
	1	5/18	7/37	0/13
p-value		0.700	0.760	1.000

metric	QC	Crew: AL	DNR	WREC
BOULDGT2	0	3/18	4/37	0/13
	1	3/18	5/37	1/13
p-value		1.000	0.722	0.308

metric	QC	Crew: AL	DNR	WREC
BOULDLT2	0	17/18	16/37	1/13
	1	12/18	17/37	2/13
p_value		0.035	0.815	0.539

metric	QC	Crew: AL	DNR	WREC
BRAIDED	0	2/18	4/37	4/13
	1	0/18	3/37	1/13
p-value		0.146	0.691	0.135

metric	QC	Crew: AL	DNR	WREC
CHANNEL	0	4/18	4/37	2/13
	1	2/18	8/37	3/13
p-value		0.371	0.207	0.619

metric	QC	Crew: AL	DNR	WREC
COBBLE	0	17/18	25/37	2/13
	1	17/18	29/37	3/13
p-value		1.000	0.295	0.619

metric	QC	Crew: AL	DNR	WREC
COMM_IND	0	1/18	7/37	0/13
	1	0/18	5/37	1/13
p-value		0.310	0.528	0.308

metric	QC	Crew AL	Crew DNR	Crew WREC
CONCRETE	0	1/18	6/37	0/13
	1	2/18	5/37	0/13
p-value		0.546	0.744	1.000

metric	QC	Crew AL	Crew DNR	Crew WREC
CONI_FOR	0	4/18	0/37	0/13
	1	4/18	1/37	0/13
p-value		1.000	0.314	1.000

metric	QC	Crew AL	Crew DNR	Crew WREC
CROPLAND	0	3/18	5/37	1/13
	1	4/18	10/37	2/13
p-value		0.674	0.148	0.539

metric	QC	Crew AL	Crew DNR	Crew WREC
DEC_FOR	0	18/18	28/37	12/13
	1	17/18	33/37	12/13
p-value		0.310	0.127	1.000

metric	QC	Crew AL	Crew DNR	Crew WREC
DEEPPOOL	0	10/18	25/37	8/13
	1	8/18	17/37	9/13
p-value		0.505	0.060	0.680

metric	QC	Crew AL	Crew DNR	Crew WREC
EFF_DIS	0	2/18	1/37	1/13
	1	0/18	0/37	0/13
p-value		0.146	0.314	0.308

metric	QC	Crew AL	Crew DNR	Crew WREC
EMER_VEG	0	2/18	3/37	4/13
	1	0/18	4/37	4/13
p-value		0.146	0.691	1.000

metric	QC	Crew AL	Crew DNR	Crew WREC
FLOATVEG	0	0/18	0/37	1/13
	1	0/18	0/37	0/13
p-value		1.000	1.000	0.308

metric	QC	Crew AL	Crew DNR	Crew WREC
GRAVEL	0	17/18	33/37	10/13
	1	15/18	33/37	9/13
p-value		0.289	1.000	0.658

metric	QC	Crew AL	Crew DNR	Crew WREC
H_REFUSE	0	12/18	31/37	8/13
	1	10/18	27/37	12/13
p-value		0.494	0.259	0.063

metric	QC	Crew AL	Crew DNR	Crew WREC
LANDFILL	0	0/18	0/37	0/13
	1	0/18	0/37	0/13
p-value		1.000	1.000	1.000

metric	QC	Crew AL	Crew DNR	Crew WREC
MEANDER	0	5/18	22/37	7/13
	1	1/18	5/37	5/13
p-value		0.074	0.001	0.431

metric	QC	Crew: AL	Crew: DNR	Crew: WREC
OH_COVER	0	14/18	31/37	12/13
	1	15/18	25/37	11/13
p-value		0.674	0.104	0.539

metric	QC	Crew: AL	Crew: DNR	Crew: WREC
OLD_FLD	0	5/18	5/37	0/13
	1	4/18	6/37	0/13
p-value		0.700	0.744	1.000

metric	QC	Crew: AL	Crew: DNR	Crew: WREC
ORCH_VIN	0	0/18	0/37	0/13
	1	0/18	0/37	0/13
p-value		1.000	1.000	1.000

metric	QC	Crew: AL	Crew: DNR	Crew: WREC
PASTURE	0	3/18	3/37	3/13
	1	3/18	1/37	1/13
p-value		1.000	0.304	0.277

		Crew		
metric	QC	AL	DNR	WREC
RESIDENT	0	7/18	10/37	1/13
	1	5/18	17/37	1/13
p-value		0.480	0.091	1.000

		Crew		
metric	QC	AL	DNR	WREC
RIFFLE	0	18/18	30/37	10/13
	1	14/18	28/37	5/13
p-value		0.034	0.572	0.047

		Crew		
metric	QC	AL	DNR	WREC
ROOTWAD	0	10/18	22/37	10/13
	1	9/18	17/37	9/13
p-value		0.738	0.244	0.658

		Crew		
metric	QC	AL	DNR	WREC
RUN_GLID	0	13/18	35/37	13/13
	1	17/18	31/37	13/13
p-value		0.074	0.134	1.000

metric	QC	Crew: AL	DNR	WREC
SAND	0	18/18	34/37	12/13
	1	14/18	34/37	13/13
p-value		0.034	1.000	0.308

metric	QC	Crew: AL	DNR	WREC
SHALPOOL	0	17/18	31/37	10/13
	1	13/18	34/37	12/13
p-value		0.074	0.286	0.277

metric	QC	Crew: AL	DNR	WREC
SILTCLAY	0	18/18	34/37	13/13
	1	16/18	33/37	12/13
p-value		0.146	0.691	0.308

metric	QC	Crew: AL	DNR	WREC
STORMDRN	0	1/18	5/37	2/13
	1	0/18	4/37	0/13
p-value		0.310	0.722	0.141

		Crew		
metric	QC	AL	DNR	WREC
STRAIGHT	0	13/18	18/37	4/13
	1	8/18	9/37	4/13
p-value		0.091	0.030	1.000

		Crew		
metric	QC	AL	DNR	WREC
SUBM_VEG	0	0/18	7/37	8/13
	1	0/18	3/37	6/13
p-value		1.000	0.174	0.431

		Crew		
metric	QC	AL	DNR	WREC
SURFMINE	0	1/18	0/37	0/13
	1	0/18	0/37	0/13
p-value		0.310	1.000	1.000

		Crew		
metric	QC	AL	DNR	WREC
UNDCTBNK	0	13/18	23/37	9/13
	1	7/18	17/37	9/13
p-value		0.044	0.162	1.000

metric	QC	Crew: AL	Crew: DNR	Crew: WREC
WETLAND	0	2/18	4/37	4/13
	1	0/18	2/37	5/13
p-value		0.146	0.394	0.680